

2. Subbasin Assessment – Water Quality Concerns and Status

This section contains the characterization of the Raft River Subbasin water quality concerns and the status of the streams of the watershed. A description of the boundaries of the water quality limited segments (from the 1998 §303(d) list) will be provided along with an identification of the listed pollutants. This section follows the specifications defined in *State of Idaho Guidance for Development of Total Maximum Daily Loads* (cite XXXX). It also follows the appropriate specifications detailed in the CWA (Federal Water Pollution, Control Act, PL 92-500 1972, amended PL 25-217 in 1977, PL 97-117 in 1981, and PL 100-4 in 1987) as amended by the Code of Federal Regulations (CFR); Idaho's Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02); and Idaho Code on Water Quality (IC §39-3601 *et seq.* [also called the WAG/BAG Law]). The objective in each of these laws and/or statutes is “declared in the 1972 CWA to restore and maintain the chemical, physical, and biological integrity of the nation's water ” (Copeland 2000 [p 3]).

2.1 Water Quality Limited Segments Occurring in the Raft River Subbasin

Water quality limited segments are streams (or segments of streams) where it is known that water quality in that particular segment does not meet applicable water quality standards. Additionally water quality limited streams are defined as those streams that are not expected to meet applicable water quality standards, even after the application of the technology-based effluent limitations required by the CWA (40 CFR § 130.2(j) and 40 CFR § 131.3(h)). IDAPA 58.01.02.003.117 supports this definition.

The process to designate water quality limited segments is established by 40 CFR § 180.7(b)(1) by EPA. Under this process, such waters require a TMDL when certain specified pollution reduction requirements (identified in 40 CFR § 130.7(b)(1)(i), (1)(ii), and (1)(iii)) are not stringent enough to implement water quality standards. Idaho Code section 39-3602 (27) requires the TMDL process for any water body not fully supporting designated or existing beneficial uses.

Pollutants may be toxic-based or nutrient-based. According to IDAPA 58.01.02.003.106 a toxic substance is “any substance, material or disease-causing agent, or combination thereof, which after discharge to water of the state and upon exposure, ingestion, inhalation or assimilation into any organism (including humans), either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, malignancy, genetic mutation, physiological abnormalities (including malfunctions in reproduction or physical deformations in affected organisms or their offspring).” Toxic substances include, but are not limited to, the 126 priority pollutants identified by EPA after § 307(a) of the CWA. On the other hand, according to IDAPA 58.01.16.002.18, a nutrient is “any one of the natural elements including, but not limited to, carbon, hydrogen, oxygen, nitrogen, potassium, phosphorus, magnesium, sulfur, calcium, sodium, iron, manganese, copper, zinc, molybdenum, vanadium, boron, chlorine, cobalt, and silicon, that are essential to plant and animal growth.” IDAPA 58.01.02.003.67 defines nutrients as “the major substances necessary for the growth and reproduction of aquatic plant life, consisting of nitrogen, phosphorus, and carbon compounds (Buhidar 2001).

Table 23 lists the 1998 §303(d) listed stream segments and reservoir and their pollutants in the Raft River Subbasin. Also listed are streams on which data are being collected for background

and headwater information prior to the next §303(d) listing cycle. The listing basis for all streams and Sublett Reservoir is the 1998 §303(d) list and the 1998 §305(b) report. See Figure 3 in Chapter 1 (under Subbasin Characteristics) for a map of stream segments.

Table 23. §303(d) listed segments and water bodies of the subbasin.

Water Body Name	Segment ID Number	1998 §303(d) ^a Boundaries	Pollutants ^b
Raft River	2430	Malta to Snake River	Ex Sed, Ex N, NH ₃ , DO, <i>E. coli</i> , Q, Sal,
Raft River	2331	Utah line to Malta	Ex Sed, DO, Tem, <i>E. coli</i> , Sal
Tributaries or Tributary Segments/Reservoir			
Sublett Creek	2432	Sublett Reservoir to lower boundaries	Ex Sed, Ex N, DO, <i>E. coli</i> , Q
Sublett Reservoir	2434	Sublett Reservoir	Ex Sed, Ex N, DO, Q
Fall Creek	7612	Headwaters to Lake Fork	U
Cassia Creek	2438	Conner Creek to Raft River	Ex Sed, Q
Cassia Creek	Not §303(d) listed	Headwaters to Conner Creek	U
Lake Creek	Not §303(d) listed	Headwaters to Sublett Reservoir	U
Van Camp Creek	Not §303(d) listed	Headwaters to Lake Creek	U
New Canyon Creek	Not §303(d) listed	Headwaters to Cassia Creek	U
Flat Canyon Creek	Not §303(d) listed	Headwaters to Cassia Creek	U

^a Refers to a list created in 1998 of water bodies in Idaho that did not fully support at least beneficial use. This list is required under section §303(d) of the Clean Water Act.

^b Q = flow alternation or diversions. Ex Sed = Excess sediments. Ex N = Excess nutrients. NH₃ = Total ammonia. DO = Dissolved oxygen. *E. coli* = *Escherichia coli*. Tem = temperature (thermal modification). U = Unknown pollutants. Sal = salinity.

2.2 Applicable Water Quality Standards

Idaho's state water quality standards divide the state into six separate hydrologic basins. In these basins, the major rivers, lakes/reservoirs, and creeks are identified (designated) for specific beneficial uses. According to IDAPA 58.01.02.101.01, surface waters not designated in the Raft River Subbasin "shall be designated according to section 39-3604, Idaho Code, taking into consideration the use of the surface water and such physical, geological, chemical, and biological measures as may affect the surface water. Any undesignated water shall be protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish, and wildlife, wherever attainable. Industrial water supplies, wildlife habitats, and aesthetics are minimum designated standards for all waters of the state.

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and “presumed” uses as briefly described in the following paragraphs. The Water Body Assessment Guidance, second edition (DEQ 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

Existing Uses

Existing uses under the CWA are “those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards.” The existing in stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.003.35, .050.02, and 051.01 and .053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. Practical application of this concept would be when a water could support salmonid spawning, but salmonid spawning is not yet occurring.

Designated Uses

Designated uses under the CWA are “those uses specified in water quality standards for each waterbody or segment, whether or not they are being attained.” Designated uses are simply uses officially recognized by the state. In Idaho these include things like aquatic life support, recreation in and on the water, domestic water supply, and agricultural use. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for waterbodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.22 and .100, and IDAPA 58.01.02.109-160 in addition to citations for existing uses.)

Presumed Uses

In Idaho, most waterbodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called “presumed uses,” DEQ will apply the numeric criteria cold water and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water is not found to be an existing use, an use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria. (IDAPA 58.01.02.101.01).

Other water quality standards, which apply to the Raft River SBA-TMDL, are in the state’s Antidegradation Policy (IDAPA 58.01.02.051.01-02). These standards read as follows:

Maintenance of Existing Uses for All Waters. The existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

High Quality Waters. Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the Department finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the Department's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the department shall assure water quality adequate to protect existing uses fully...

IDAPA 58.01.02.50.01 states:

Apportionment of water. The adoption of water quality standards and the enforcement of such standards is not intended to conflict with the apportionment of water to the state through any of the interstate compacts or court decrees, or to interfere with the rights of Idaho appropriators, either now or in the future, in the utilization of the water appropriation which have been granted to them under the statutory procedure...

IDAPA 58.01.02.50.02.a states:

Wherever attainable, surface waters of the state shall be protected for beneficial uses which for surface waters includes all recreational uses in and on the water surface and the preservation and propagation of desirable species of aquatic biota...

IDAPA 58.01.02.50.02.c states:

In all cases, existing beneficial uses of the water of the state will be protected.

Table 24 summarizes Idaho's beneficial uses and criteria for its water bodies. Those uses designated for selected water bodies within the Raft River Subbasin, as defined in IDAPA 58.01.02.15, can be found in Table 25.

Table 24. State of Idaho's recognized beneficial uses.

BENEFICIAL USES	APPLICABLE CRITERIA
Agricultural Water Supply	Water quality appropriate for the irrigation of crops or as drinking water for livestock. This use applies to all surface waters of the state (IDAPA 58.01.02.100.03.b). Numeric criteria as needed are derived from the EPAs <i>Water Quality Criteria</i> 1972 (EPA 1975). (IDAPA 58.01.02.252.02).
Domestic Water Supply	Water quality appropriate for drinking water supplies (IDAPA 58.01.02.100.03.a). Numeric criteria for specific constituents and turbidity (IDAPA 58.01.02.252.01.a-b).
Industrial Water Supply	Water quality appropriate for industrial water supplies. This use applies to all waters of the state (IDAPA 58.01.02.100.03.c). Numeric criteria are categorized as general surface water quality criteria (IDAPA 58.01.02.252.03).
Cold Water Aquatic Life	Water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species (IDAPA 58.01.02.100.01.a). Numeric criteria are established for pH, dissolved oxygen, gas saturation, residual chlorine, water temperature, ammonia, turbidity, and toxics (IDAPA 58.01.02.250.02.a-g).
Seasonal Cold Water Aquatic Life	Water quality appropriate for the protection and maintenance of a viable aquatic life community of cool and cold water species (IDAPA 58.01.02.100.01.c). Numeric criteria are established for pH, dissolved oxygen, gas saturation, residual chlorine, water temperature, ammonia, turbidity, and toxics (IDAPA 58.01.02.250.03.a-c).
Warm Water Aquatic Life	Water quality appropriate for the protection and maintenance of a viable aquatic life community for warm water species (IDAPA 58.01.02.100.01.d). Numeric criteria are established for pH, dissolved oxygen, gas saturation, residual chlorine, water temperature, ammonia, and toxics (IDAPA 58.01.02.250.04.a-c).
Modified Aquatic Life	Water quality appropriate for an aquatic life community that is limited due to one (1) or more conditions set forth in 40 CFR 131.10(g) which preclude the attainment of reference streams or conditions (IDAPA 58.01.02.100.01.e). Numeric criteria for pH, dissolved oxygen, gas saturation, residual chlorine, water temperature, ammonia, and toxics will be considered on a case by case basis (IDAPA 58.01.02.250.05).
Salmonid Spawning	Waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes (IDAPA 58.01.02.100.01.b). Numeric criteria are established for pH, gas saturation, residual chlorine, dissolved oxygen, intergravel dissolved oxygen, water temperature, ammonia, and toxics (IDAPA 58.01.02.250.02.e).
Primary Contact Recreation	Water quality appropriate for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such waters include, but are not restricted to, those used for swimming, water skiing, or skin diving. (IDAPA 58.01.02.100.02.a). Numeric criteria are established for <i>Escherichia coli</i> bacteria (IDAPA 58.01.02.251.01.a-b).
Secondary Contact Recreation	Water quality appropriate for recreational uses on or about the water which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming, and other activities where ingestion of raw water is not likely to occur (IDAPA 58.01.02.100.02.b). Numeric criteria are established for <i>Escherichia coli</i> bacteria (IDAPA 58.01.02.251.02.a-b).
Wildlife Habitats	Water quality appropriate for wildlife habitats. This use applies to all surface

BENEFICIAL USES	APPLICABLE CRITERIA
	waters of the state (IDAPA 58.01.02.100.04). Numeric criteria are categorized as general surface water quality criteria (IDAPA 58.01.02.253.01).
Aesthetics	This use applies to all surface waters of the state (IDAPA 58.01.02.100.05). Numeric criteria are categorized as general surface water quality criteria (IDAPA 58.01.02.253.02).
Special Resource Water	Those specific segments or water bodies that are recognized as needing intensive protection to preserve outstanding or unique characteristics. Designation as a special resource water recognizes at least one of the following characteristics: (1) the water is of outstanding high quality, exceeding both criteria for primary contact recreation and cold water aquatic life; (2) the water is of unique ecological significance; (3) the water possesses outstanding recreational or aesthetic qualities; (4) intensive protection of the quality of the water is in paramount interest of the people of Idaho; (5) the water is part of the National Wild and Scenic River System, or is within a state or National Park or wildlife refuge and is of prime or major importance to that park or refuge; (6) intensive protection of the quality of the water is necessary to maintain an existing but jeopardized beneficial use (IDAPA 58.01.02.056). Special resource waters receive additional point source discharge restrictions (IDAPA 58.01.02.054.03 and 400.01.b).
NOTE: All waters are protected through general surface water quality criteria. Narrative criteria prohibit ambient concentrations of certain pollutants that impair designated uses. Narrative criteria are established in Idaho water quality standards for hazardous materials; toxic substances; deleterious materials; radioactive materials; floating, suspended, or submerged matter; excess nutrients; oxygen demanding materials; and sediment (See IDAPA 58.01.02.200.01-08).	

Table 25 Raft River Subbasin designated beneficial uses.

Water Body	Designated Uses ^a	1998 §303(d) List ^b
RAFT RIVER SEGMENTS – DESIGNATED BENEFICIAL USE		
Raft River, Malta to SR 2430	CW, SS, PCR	Yes
Raft River, Utah line to Malta 2331	CW, SS, PCR	Yes
TRIBUTARY SEGMENTS-EXISTING BENEFICIAL USES		
Sublett Creek, Sublett Reservoir to lower boundaries 2432	AWS	yes
Sublett Reservoir 2434	CW, SS, PCR, SCR, AWS	Yes
Fall Creek, Headwaters to Lake Fork 7612	CW, SS, PCR, SCR, AWS	yes
Cassia Creek, Conner Creek to Raft River, 2438	CW, SS, PCR, SCR, AWS	yes

^a CW – Cold Water, SS – Salmonid Spawning, PCR – Primary Contact Recreation, SCR – Secondary Contact Recreation, AWS – Agricultural Water Supply, DWS – Domestic Water Supply

^b Refers to a list created in 1998 of water bodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection “d” of the Clean Water Act.

2.3 Summary and Analysis of Existing Water Quality Data

Water quality data within the Raft River Subbasin are very sparse. Five USGS gauges exist(ed) within the subbasin. These gauges will be used to develop hydrographs for the remaining ungauged watersheds. Other entities collecting data include the IDFG, USFS, BLM, and EPA. The fish collections (IDFG) were usually done in conjunction with the BLM or USFS for their management needs. However, these collections are very limited. Some information exists within the EPA's STORET database. Again, this information is very limited or applicable to non-water quality limited streams. In all cases STORET was queried for each water quality limited water body within the subbasin. For the most part, DEQ TMDL monitoring data and Beneficial Use Reconnaissance Program information make up the largest, or only, portion of the available data.

Stream Characteristics

The subbasin is cartographically covered by 1:24,000-scale and higher USGS topographic quadrangle maps. The total vertical relief in the area is 1,861 m, ranging from a low elevation of approximately 1,290 m near Snake River to a high elevation of 3,151 m at Cache Peak in the Albion Mountains. Locally, slopes on the alluvial fans are usually quite gentle (although overall relief to the canyons and valley bottoms is considerable), with considerably steeper slopes in the mountains.

The topography is chiefly an expression of the geologic structure and historical glacial and sedimentary processes. The faulted, linear mountain chains of the Basin and Range ecoregion border the Snake River Basin Plain to the south. In general, the subbasin slopes from the southeast and southwest towards the Snake River in the north.

As stated previously, the Raft River Subbasin covers approximately 3,919 km² in total area. Nearly 3,196 km², or 81.55 percent of the subbasin, are within the state of Idaho. The Idaho portion of the subbasin contains both the highest and lowest elevation points. The average elevation of the entire subbasin is approximately 1,571 m. The entire subbasin slope range is from less than 1 percent to 46 percent. The average subbasin slope is approximately 1.97 percent (Change in elevation divided by overall subbasin length). Generally, the alluvial valleys have slopes of less than 1 percent, while the remainder of the subbasin is mountainous and has slopes greater than 10 percent. Overall, the subbasin has a northeastern aspect. The stream channels and mainstem rivers follow a dendritic drainage pattern throughout the subbasin. In the subbasin, there are 503.0 km of perennial streams; 3,3317.6 km of ephemeral and intermittent streams; and 15.4 km of canals and ditches. Roughly 40 percent of the perennial streams are located between 1,524 and 1,829 m elevations, which corresponds with the alluvial low slope area of the subbasin. Approximately 75 percent of the ditches are located in the 1,219 to 1,524 m elevation classification. This area corresponds with the lowland agricultural area from near Malta to the Snake River. In this same area 148.2 km of perennial streams exist.

Additionally, the subbasin has been further subdivided into 21 watersheds (See Figure 9). These units will be used extensively in allocating nonpoint source loads.

Raft River

Raft River begins in the north central mountains of Utah (Grouse Creek and Raft River Mountains) and the south central mountains (Albion Mountains and Middle Mountain) of Idaho and flows to the confluence of the Snake River. Raft River flows from Utah into Idaho.

Approximately 122.5 km are in Idaho. Along this course, several perennial tributaries (e.g., Cassia Creek, Edwards Creek, and North and South Junction Creeks) enter the system, as do numerous intermittent and ephemeral systems. Three USGS gauge locations are used or have been in use historically in Idaho. The uppermost location of the current gauge is near Onemile Creek at the Raft River Narrows. A historical gauge location is downstream from The Narrows gauge below Onemile Creek. The lowermost gauge was located at the mouth near the Snake River. The lowermost gauge was in operation from April 1985 until July 1989, with a contributing watershed area of 1,510 mi². Given this size watershed, channel characteristics can be extrapolated from regional curves. These regional curves can be found in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, the Raft River at this sampling location should have a mean depth of 2.00 m, a bankfull width of 92.37 m and a cross-sectional area of approximately 129.29 m². From the historical gauge data, the period of record average discharge at this location was 0.31 cubic meters per second (m³/s). Low discharge occurred during the fall quarter with only 0.02 m³/s. Spring discharge was 0.77 m³/s, while winter base discharge was 0.22 m³/s. Summer discharge was 0.19 m³/s (see Figure 19).

At the upper location, the current USGS gauge, discharge averaged 0.57 m³/s for the period of record (October 1946 to September 2001). Low discharge occurred during the fall quarter with only 0.24 m³/s. Spring discharge was 1.08 m³/s, while winter base discharge was 0.50 m³/s. Summer discharge was 0.46 m³/s (Figure 20).

Physical Characteristics

The upper segment of the two §303(d)-listed segments of the Raft River begins at the Utah-Idaho border. This segment is 67.90 km long. The valley through which this segment flows is approximately 53 km in length. Over the entire listed segment, the creek has a very low slope of 0.409 percent. This slope corresponds to a 4-m fall per kilometer. Slopes of this magnitude are usually seen in highly sinuous streams that are by nature depositional. Sinuosity is classified as moderate (1.3) for the listed segment. Floodplain materials are composed of fine textured sands and silts derived from alluvium and glacial till. Consequently, it would be expected that the percent fines of Raft River should be elevated in comparison to a channel with much higher slopes, lower sinuosity, and coarser floodplain materials. In this case, percent fines would be comparable to the lower section of Trapper Creek in the Goose Creek Subbasin.

Hydrology

As stated in the pervious section, a USGS gauge has been in operation since 1946. The average annual hydrograph for the Raft River period of record discharge is shown in the following figures (Figures 19 and 20).

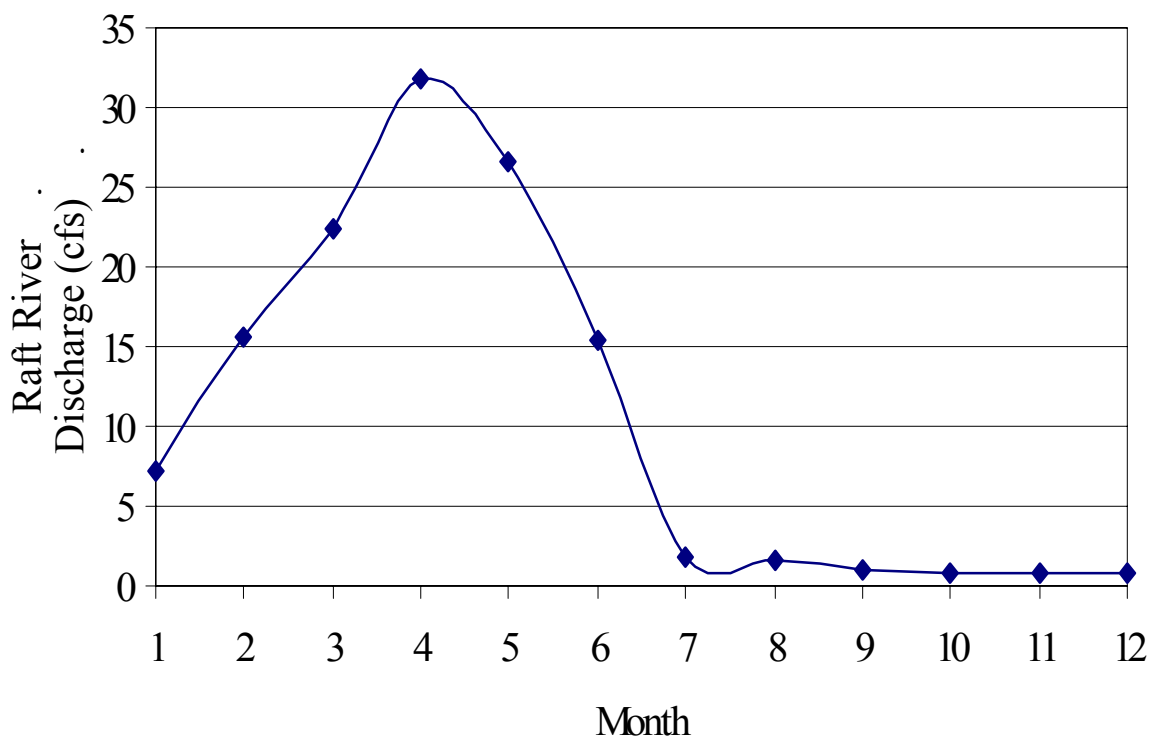


Figure 19. Discharge as measured at the mouth of Raft River near the Snake River.

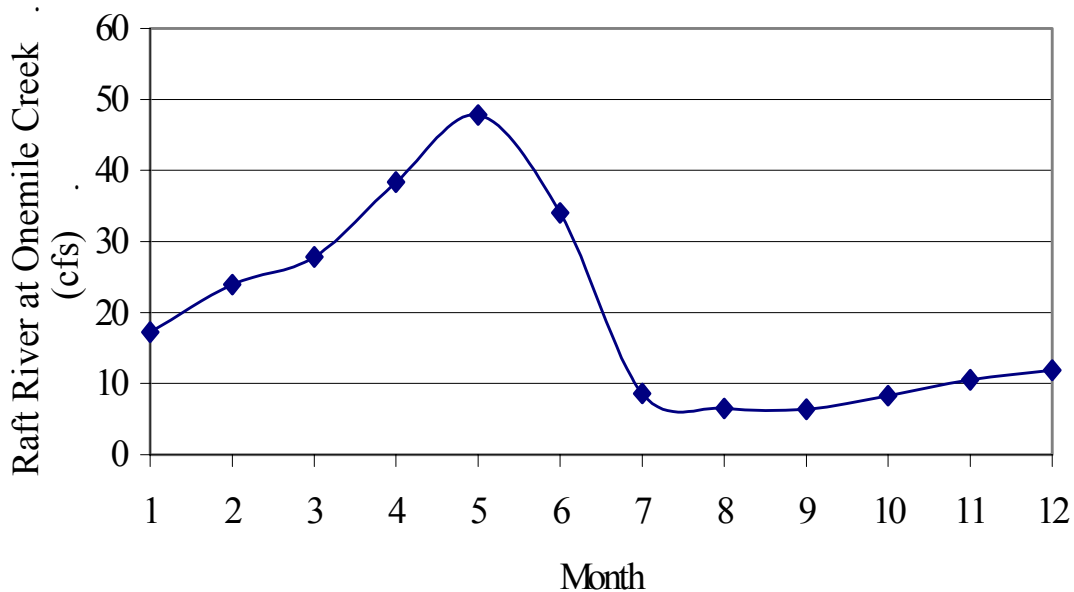


Figure 20. Discharge as measured at The Narrows of Raft River near Onemile Creek.

Raft River Existing Water Quality Data

Water quality samples containing a full suite of constituents collected within the lower listed segment of the Raft River are rare. Upon a review of the STORET database, two locations were sampled in the lower section and one in the upper section. Approximately 23 site visits were made in the lower section and seven in the upper location. These visits were spread out from 1961 to 1977. For each of the listed constituents in the lower section the overall average of the historical data is presented in Table 26.

Table 26. Lower Raft River historical water quality data (1961-1977).

Parameter ^a	Average ^b	Standard Deviation
Bacteria	1,236 colonies/100 ml (fecal <i>coli</i>)	2,131
Dissolved Oxygen	8.75 mg/L	3.51
Total NH ₃	0.31 mg/L	0.50
Nutrients (TP)	0.16 mg/L	0.16
Nutrients (NO _x)	1.03 mg/L	0.97
Sediment	53 mg/L	87
Flow Alteration	3 cfs (22-24 Aug 1971)	0.00

^a NH₃ = ammonia, TP = total phosphorus, NO_x = nitrogenoxides.

^b ml = milliliters, fecal *coli* = fecal *coliforms*, mg/L = milligrams per liter.

From this data and the older fisheries information, a sense of the historical water quality can be gathered. In the decades following these collections many nonpoint source changes have occurred. The USFS and BLM have tightened grazing regulations, land ownership has changed, our knowledge of water quality and BMPs has increased, and most importantly our use of water has changed dramatically in the lower section. These changes are evident in the most recent data collection attempts in the lower segment of Raft River. In this section, Raft River rarely has water flowing in it. Discharge near the end of August is unheard of.

Historical data collected in the upper segment are much sparser than in the lower section. Table 27 presents the averages of the seven data collections made in the Raft River Narrows.

Table 27. Upper Raft River historical water quality data.

Parameter ^a	Average ^b	Standard Deviation
Bacteria	Not Collected	Not Collected
Dissolved Oxygen	8.90 mg/L	2.97
Total NH ₃	0.42 mg/L	0.44
Nutrients (TP)	Not Collected	Not Collected
Nutrients (NO _x)	1.49 mg/L	0.64
Sediment	4 mg/L	1 sample
Flow Alteration	Not Collected	NC

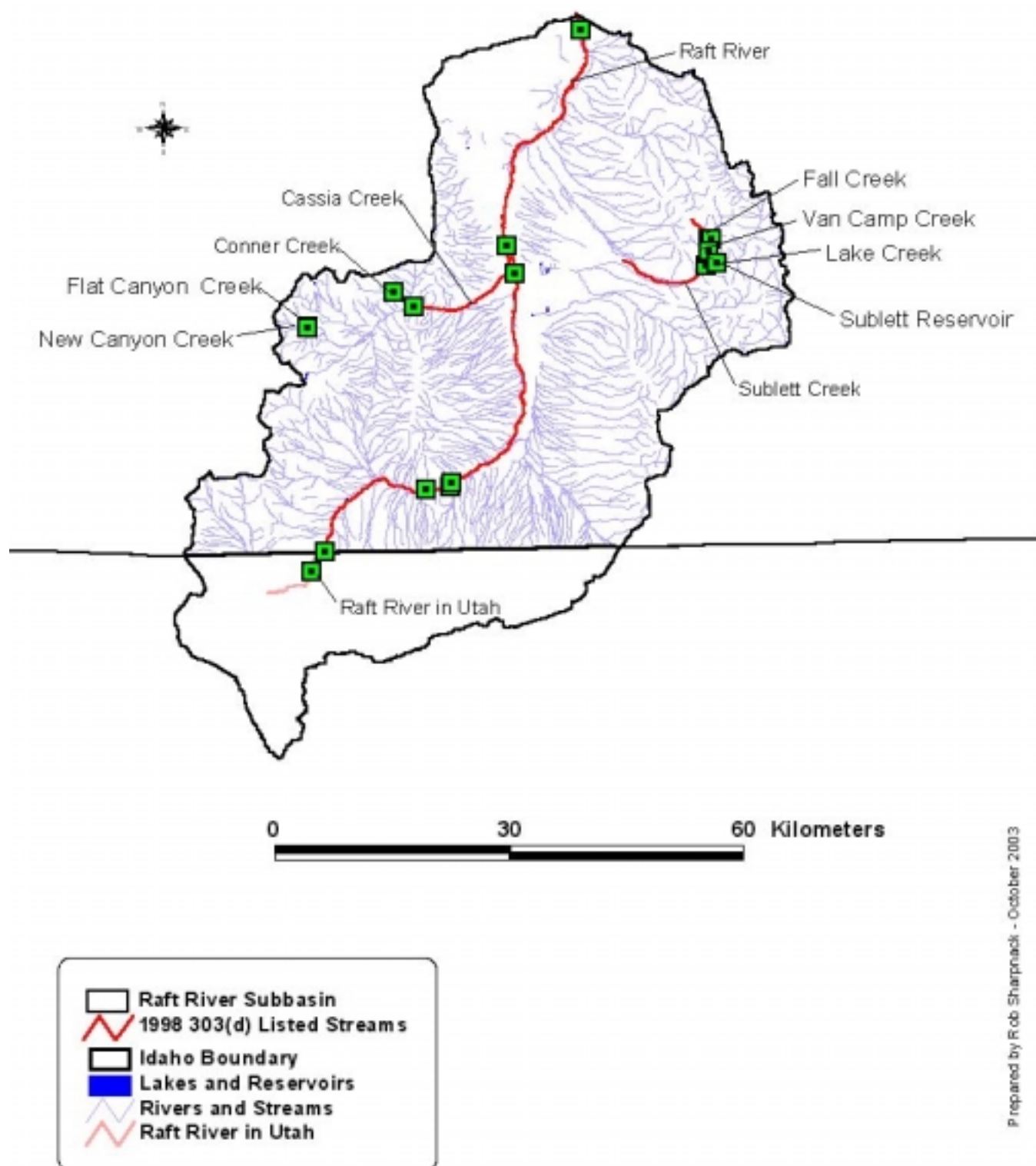
^a NH₃ = ammonia, TP = total phosphorus, NO_x = nitrogenoxides.

^b ml = milliliters, mg/L = milligrams per liter.

DEQ sampled in the creek over the course of 1999-2002. Additional samples were collected by the Soil Conservation District (SCD) throughout the summer of 1999. However, due to the limited number of sampling periods in the data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in some months. This sampling design was intended to determine annual pollutant loads. The annual load estimated by this type of design would overestimate the annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and in the tables and used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

For the upper segment of Raft River four sample locations were intermittently sampled beginning in March of 1999 (Figure 21). No samples were collected by either DEQ or the SCD in the lower segment. This was because water was not available to sample in the lower segment on any of the sampling dates. Therefore, the lower section will remain on the §303(d) list for flow alteration. At such time that flows in the lower section return, water quality samples will be taken and the water quality will be assessed.

Water quality information was collected from multiple locations in the upstream segment to determine background concentrations and loads from the upstream segments of the river and from out of state.



Prepared by Rob Sharpnack - October 2003

Figure 21. Monitoring locations throughout the Raft River Subbasin.

The chemical constituents at all sites seemed to be very similar throughout the sampling period. In order to determine if this was the case, an analysis of variance (ANOVA) test was conducted to test the null hypothesis (H_0).

H_0 : Raft River Utah Mean = Raft River UT/ID Border Mean = Raft River Edwards Mean = Raft River Narrows Mean.

H_a : Raft River Utah Mean \neq Raft River UT/ID Border Mean \neq Raft River Edwards Mean \neq Raft River Narrows Mean.

Each constituent sampled at the four locations was tested using Systat 7.0. For most constituents the null hypothesis was not rejected ($p > 0.05$). However, pH, total dissolved solids, and specific conductivity (SC) were significantly different from station to station (Table 28). Therefore, for these constituents, the null hypothesis was rejected. A Bonferroni post hoc test was conducted to determine which stations were significantly different from one another. The Raft River site located at The Narrows was the only site different from the other three. This was similar for all three constituents. The change in all three constituents is likely a natural phenomenon in that the Raft River often dries up in the upper reaches and a large spring source is located at The Narrows location. This spring would be much higher in dissolved salts than the surface runoff waters from the upper reaches. While the change could be associated with anthropogenic disturbances, other constituents (total phosphorus [TP], nitrate plus nitrite [NO_x], ammonia [NH_3], and total suspended solids [TSS]) associated with such disturbances do not reflect the same change.

For the most part the statistical tests allow DEQ to pool the water quality data together to allow a more robust understanding of the chemical nature of the upper segment of Raft River. Those pooled results are presented in Table 29.

Table 28. Analysis of variance p values for four sample locations.

Constituent	Significance Value (p)
Temperature	0.127
Dissolved Oxygen	0.981
Specific Conductivity	0.000
pH	0.000
Total Dissolved Solids	0.000
Total Suspended Sediment	0.427
Total Ammonia	0.192
Nitrate + Nitrite	0.578
Total Phosphorus	0.088
<i>E. coli</i>	0.629

Table 29. Monthly average water quality constituents in Raft River ID.

Month	No of Samples	TSS (mg/L) ^a	Total NH ₃ as N (mg/L) ^b	Total NO ₂ + NO ₃ as N (mg/L) ^c	Total P (mg/L) ^d	Temp (°C) ^e	Dissolved Oxygen (mg/L) ^f	Bacteria <i>E. coli</i> (Col/100 ml) ^g
January	2	96				3.2	10.97	125
February	2	34				4.9	10.59	5
March	2	44				7.2	10.05	55
April	9	86	0.024	0.113	0.160	9.4	9.47	111
May	14	33	0.050	0.012	0.105	12.9	8.94	363
June	11	28	0.133	0.011	0.076	16.5	8.97	267
July	8	12	0.019	0.014	0.085	19.3	8.53	311
August	14	14	0.015	0.010	0.094	18.1	8.59	515
September	10	10	0.014	0.009	0.056	12.6	9.72	61
October	9	22	0.015	0.008	0.075	9.3	9.99	430
November	4	23	0.015	0.013	0.054	3.3	13.33	100
December	2	34				0.8	11.87	5
Average	87	30	0.04	0.02	0.090	12.7	9.48	276
Standard Deviation		35	0.11	0.04	0.050	5.5	1.48	776

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.

b Total ammonia as nitrogen in milligrams per liter.

c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO₂+NO₃ detection limit = 0.005mg/L.

d Total phosphorus in milligrams per liter.

e Temperature in degrees Celsius.

f milligrams per liter.

g colonies per 100 milliliters.

Total dissolved solids and SC information is provided, in Table 30, from each location due to the statistical tests indicating a significant difference among locations (most likely due to different water sources).

The pooled data collected on Raft River from the Utah State line to Malta indicate that when and where there is water in Raft River it is of moderate water quality. Although not a listed parameter, nutrients are low to moderate and nutrients do not appear to impact water quality. Total phosphorus averages 0.09 milligrams per liter (mg/L) on an annual basis with a few spikes in the early season runoff period. However, during the critical period for water quality, summer low flow, TP values are below target values set in other rivers in the Twin Falls Region (0.1 mg/L). Additionally, the other components of nutrients are not elevated and nitrate plus nitrite and total NH₃ values are very low. The data support the original non-listing of nutrients in this section of the river.

Table 30. Total dissolved solids and specific conductivity from four Raft River locations.

Month	Narrows TDS ^a	Narrows SC ^b	Utah Location TDS	Utah Location SC	Below Edwards Creek TDS	Below Edwards Creek SC
Mean	651	1,148	346	538	354	747
Standard Deviation	187	246	39	63	83	170
Minimum	335	523	300	469	247	520
Maximum	913	1,426	433	677	504	1,058
Number of Samples	44	44	18	18	16	16

^a TDS = total dissolved solids.

^b SC = specific conductivity.

Instantaneous dissolved oxygen (DO) concentrations never fall below state water quality standards. At the four locations 7.12 mg/L DO was the lowest value recorded. This, coupled with the lack of a nutrient problem, leads DEQ to conclude that oxygen demanding materials are likely minimal in the segment. However, a data gap concerning diel DO fluctuations exists. In the future, a diel oxygen concentration study should be undertaken to answer the question more fully. However, at this time DEQ concludes that oxygen demanding materials that would lead to low DO as a pollutant do not exist within the listed segment of Raft River.

Sediment is listed in the upper segment as a pollutant. As the data indicates, suspended sediment also is a low to moderate concern in the segment. Occasional elevated samples are seen during peak runoff events. These are more frequent in the early spring and winter months following storm events. These storm events likely redistribute the sediments from within the channel and from the banks. On an annual basis, however, the data does not support the need for a suspended sediment TMDL in this segment of Raft River. During the spring critical period for salmonid spawning suspended sediments are elevated for very brief periods of time (storm events), but on average do not exceed recommended targets (50-80 mg/L). Bank erosion inventories collected within the segment indicate that bank stability ranges from 87 percent to 50 percent. The reaches with highly stable banks are generally associated with perennial water near The Narrows, while those reaches with high percentages of unstable banks are typically found in the more flow altered portions of the Upper Raft River segment near the Utah border and above Malta. A bed load sediment TMDL will likely address the elevated spring and winter TSS events better than an annual suspended sediment TMDL would.

Bacteria samples were also collected with the water chemistry samples at all of the locations. Bacteria exceeded the instantaneous state water quality standards for secondary contact recreation seven times. In most cases, the bacteria concentrations were lower in the downstream sampling locations than in the upper. Three of the exceedances of Idaho's instantaneous water quality standards were observed at the Utah testing location. However, it should be noted that this upper location is not within the jurisdiction of the Idaho water quality standards. It appears from the data that some improvement in water quality occurs, with regards to bacteria, from the upstream to downstream locations. However, the sample sets were not significantly different ($p = 0.511$); therefore, the amount of improvement should be considered insignificant as well. Of

the remaining four instantaneous exceedances, three occurred at The Narrows location. The remaining sample was from the below Edwards Creek location. This location was sampled by the SCD and follow-up monitoring to calculate a geometric mean was not undertaken. However, a geometric mean calculated from the five closest samples, including the exceedance, yields a geometric mean of 135. These samples were collected from September 7 to December 20. It is likely that had follow-up monitoring taken place within 30 days as required, the geometric mean would have been much higher. Due to the lateness in the year and changes in land use that occur with the changing seasons, the bacteria counts were changing dramatically. Even with the dramatic decreases a geometric mean standard violation occurred. Thus, it is highly probably that bacteria exceeded state water quality standards in the upper Raft River segment near Edwards Creek.

The final three instantaneous violations occurred at the Raft River Narrows sampling location on July 29, 1999, May 20, 2002, and June 3, 2002. Follow-up monitoring for the 1999 exceedance did not occur. However, the May 20 exceedance was followed up and included the June 3 sample. Five samples were collected within the 30 day period of May 5, 2002 and June 3, 2002. The geometric mean of these five samples was 349, a clear exceedance of state water quality standards.

Temperature studies were also undertaken at two locations along Raft River. HOBO temp loggers were placed at the Raft River Narrows location and at the Utah location. Previous ANOVA results indicated that the instantaneous temperatures were not significantly different between these two locations. Instantaneous temperature measurements from the upstream (Utah) location and the lower location were statistically similar ($p = 0.379$). This may indicate that water quality impacts are similar through the upper segment of Raft River from Utah through Idaho. HOBO loggers were placed at these locations for four years (1999-2002). The upper-most was located just south of the Idaho border near Yost, Utah. Another was placed at The Narrows where the instantaneous samples were collected. The HOBOs were running concurrent with each other in 2000, and 2001, but not in 1999 and 2002 when the Utah logger was not placed. Box plots of the daily means show that the temperature is slightly lower at the Utah location (Figure 22). Water quality standards violations were common at both locations, although the Utah location rarely had exceedances in 2000. At The Narrows location exceedances were quite common in 2001, but fewer violations occurred in the other years. Daily maximum temperature violations also occur at The Narrows site commonly (Figure 23). Consequently, a temperature TMDL for the entire creek will be required. The TMDL may have to include Utah. Consequently, EPA may be required to take the lead of this multi-state, multi-regional TMDL if the implementation of the Idaho temperature TMDL proves ineffective.

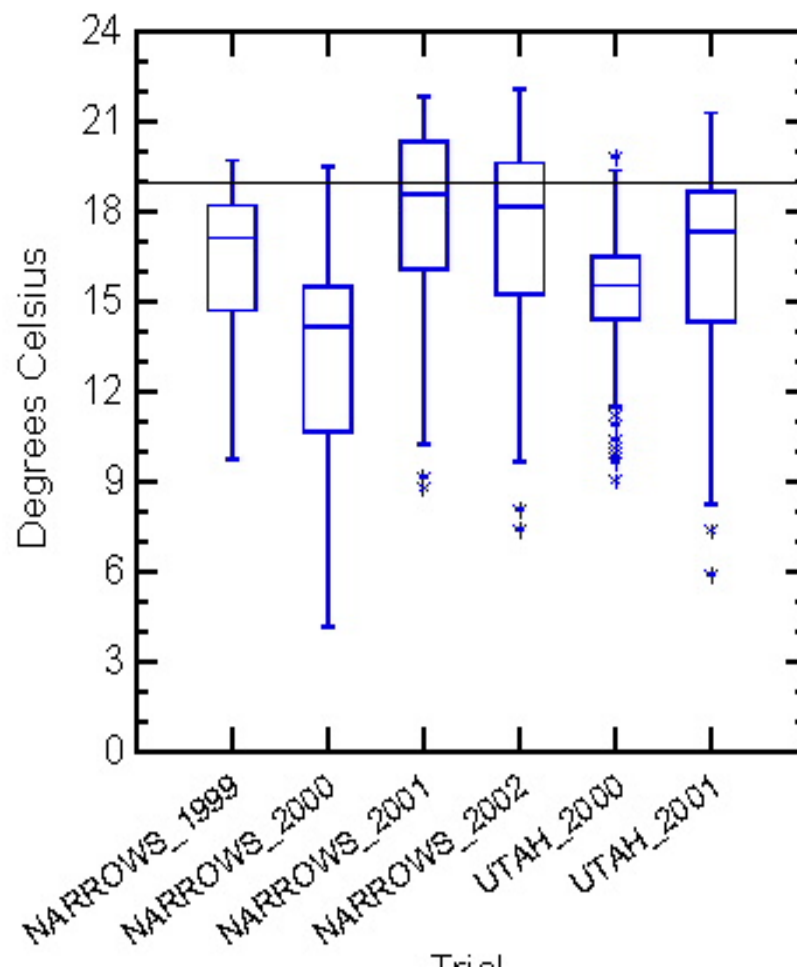


Figure 22. Daily mean temperatures at two Raft River locations over four years.

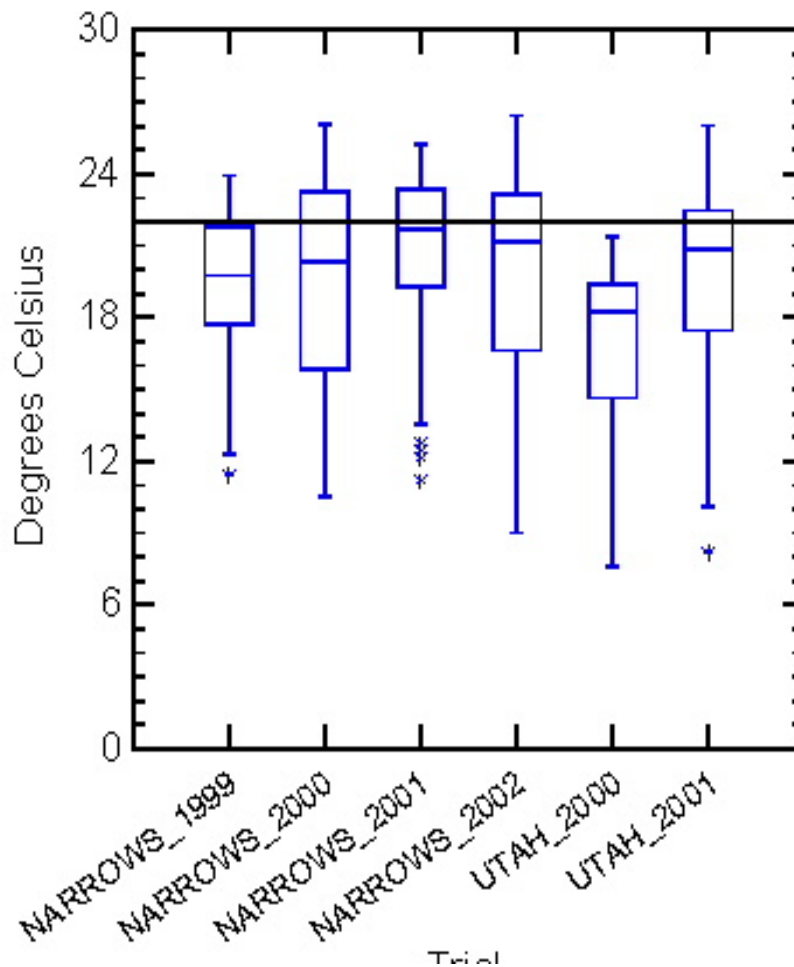


Figure 23. Maximum temperature measurements at two Raft River locations for four years.

The upper segment of Raft River is also listed for salinity, the only water body in the state so listed. Consequently, much of the information pertaining to the assessment of salinity will be based on other states' salinity TMDLs. The primary TMDL used to guide much of the analysis was the Big Sandy Creek Salinity TMDL prepared by the Montana Department of Environmental Quality (MDEQ) (Bauermeister 2001). The MDEQ uses SC and total dissolved solids (TDS) as the parameters to determine if salinity is a problem within their streams. Additional measures of sulfates and chlorides are also made. However, DEQ has only collected TDS and SC measures. These should suffice in making the determination of impairment based on the Montana criteria.

Montana suggests TDS and SC as measures because they measure the total mineral content of a water body. Additionally, SC and TDS are related and the SC/TDS relationship is unique to each stream based upon geology and ground water influence. The SC/TDS relationship for pooled Raft River sites visually appears to suggest two different sources of water or SC/TDS relationships (Figure 24).

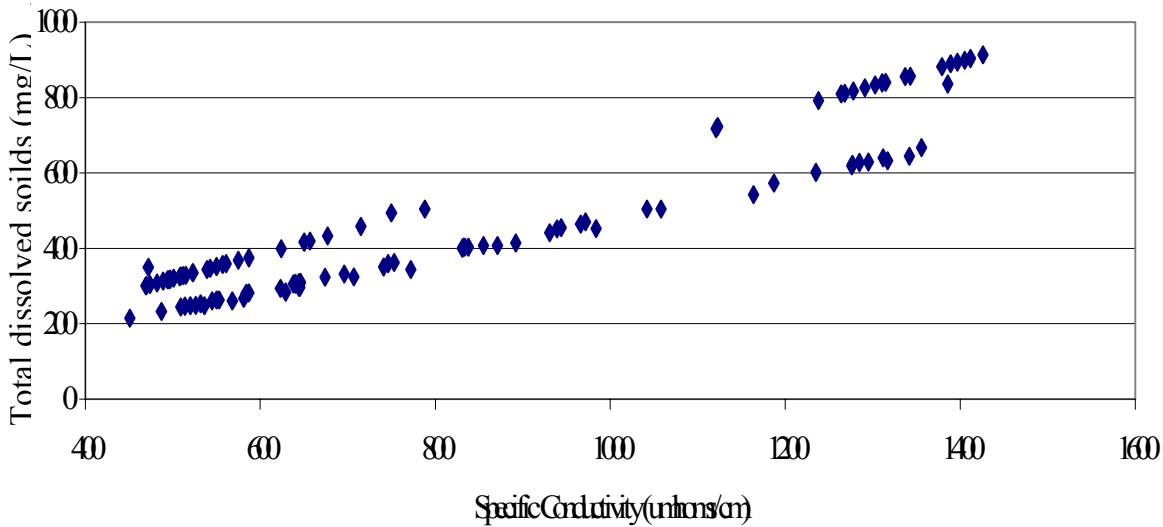


Figure 24. Total dissolved solids /specific conductivity relationship for the pooled Raft River data.

The overall statistical relationship; however, is significant ($p < 0.05$) and the fit is very high ($r^2 = 0.879$) for the pooled data. However, previous ANOVA indicated that the sample locations were significantly different ($p = 0.000$). The Bonferroni post hoc test indicated that the Raft River Narrows location was significantly different than the other three locations. In addition, this location also had the highest measured SC and TDS. Therefore, it is likely that this area has the highest probability of a salinity problem. However, ground water plays a bigger role in the hydrology of this location than that of the other three.

The TDS/SC relationship for The Narrows location seems to break down much more than the overall relationship, likely because of more year-to-year variation in the percent of ground water contribution. For example, in the drier years of 2001 and 2002, a higher percentage of the water at The Narrows was likely ground water.

An ANOVA was conducted on the year-to-year data collected at The Narrows location and it was determined that there were significant differences year-to-year in both TDS and SC ($p = 0.027$ and 0.048 respectively). Again, Bonferroni post hoc tests were used to determine which years were different. For TDS it appears that 1999 and 2001 were significantly different ($p = 0.045$) from other years, while the remaining years were not significantly different from each other ($p > 0.05$). Therefore, the TDS relationship should be best if 1999 and 2001 were excluded. However, this was not the case. The best fit to the relationship came if each year was plotted separately. In this case, the r^2 's ranged from 0.89 to 1.0. Pooling them together resulted in an r^2 of 0.792 (Figures 25 and 26).

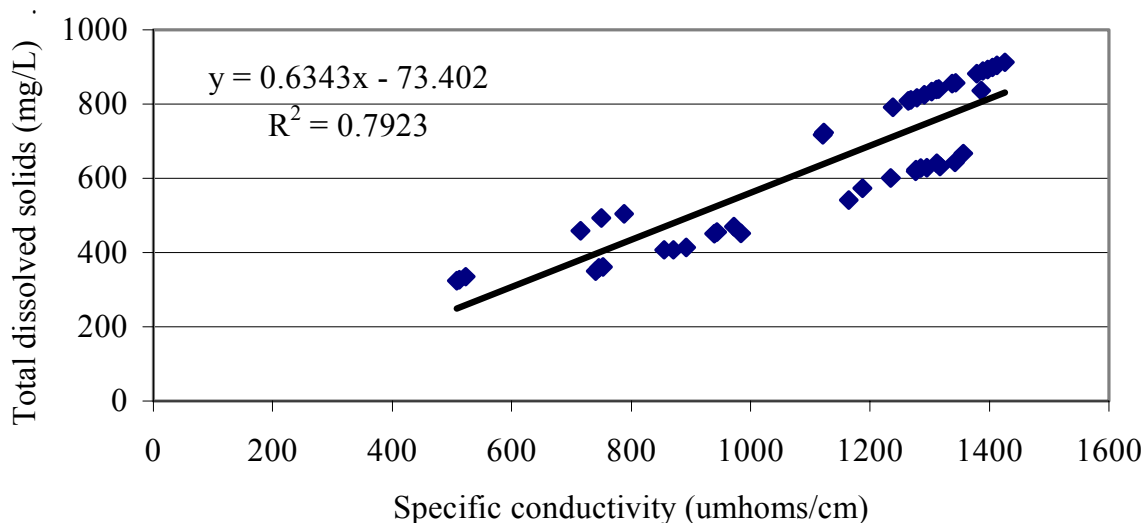


Figure 25. Total dissolved solids /specific conductivity relationship at the Raft River Narrows for four years.

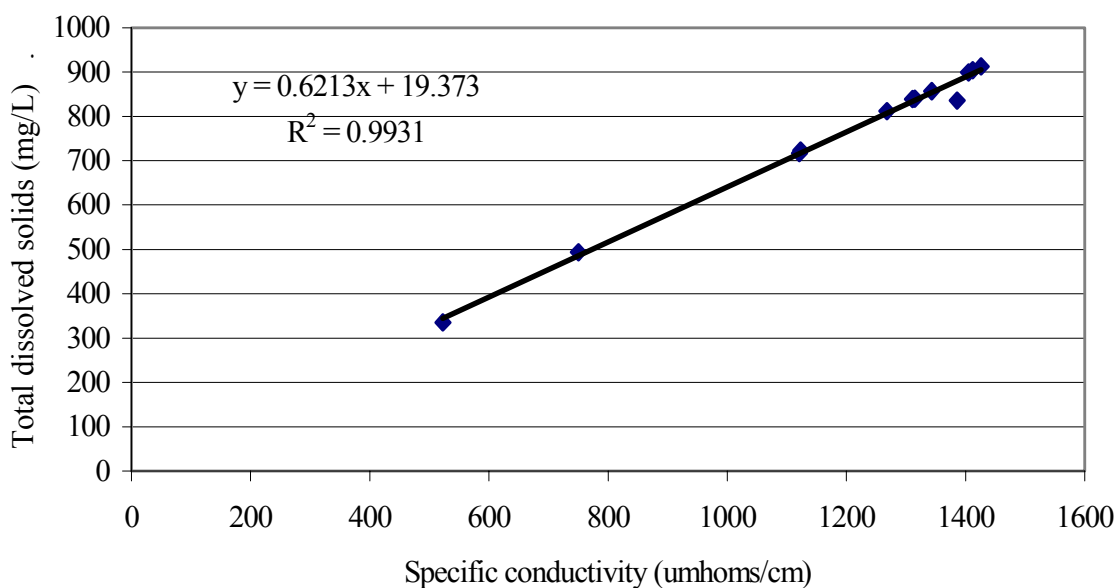


Figure 26. Total dissolved solids /specific conductivity relationship at the Raft River Narrows in 2001.

The TDS/SC relationship is important in the Big Sandy TMDL because the target selected was SC, yet the unit measured for compliance was TDS. In order to predict TDS year-to-year regardless of water conditions, the pooled relationship should be used because it covers a wider range of background conditions. Care should be noted, however; that the fit of the relationship and therefore the predictive ability of the relationship is somewhat less than using a single year.

The next step in the MDEQ TMDL was to identify a reference watershed against which to compare the SC values of Big Sandy Creek. In our case, an appropriate reference system for Raft River likely does not exist. However, the values generated in the Big Sandy Creek TMDL may suffice as they are conservative especially in comparison to other standards and guidelines as cited in the Big Sandy TMDL. For example, stock water guidelines for SC are below 5,000 microhms per centimeter ($\mu\text{mhoms/cm}$), SC greater than 2,200 $\mu\text{mhoms/cm}$ can reduce the yield of alfalfa, and *Daphnia magna* suffers 6 percent mortality at 1,600 $\mu\text{mhoms/cm}$ (Bauermeister 2001). The reference location for the Big Sandy TMDL was often below 1,600 $\mu\text{mhoms/cm}$. Based on these values, MDEQ chose 1,600 $\mu\text{mhoms/cm}$ as the value to determine the creek-specific TDS target for any subsequent TMDLs.

As this relates to the Raft River, the target or assessment guideline to determine if TDS/salinity is impairing beneficial uses would be derived from the TDS/SC relationship in Figure 25, or 942 mg/L TDS. A review of all the data collected from Raft River reveals that no TDS values over the guideline were measured.

It appears from the data that suspended sediment, nutrients, DO, and TDS/salinity are within the bounds of water quality determined to be supportive of the designated beneficial uses. Consequently, DEQ will not complete a TMDL for these parameters on the creek. However, DEQ will complete TMDLs for bed load sediment, bacteria, and temperature. Flow alteration will remain on the §303(d) list as pollution and no TMDL will be completed for this parameter at this time. At such time that pollution TMDLs are generated, DEQ will undertake the necessary data collection and analysis to complete a flow alteration TMDL.

Point and Nonpoint Sources

The upper listed segment of the Raft River bisects two fifth field HUCs, 1704021107 and 1704021106. Geographic information systems (GIS) coverages indicate that 1.7 percent of the watershed is urban, 28.2 percent is irrigated croplands, and 70.1 percent is forest or rangelands. These are the major sources of nonpoint source pollution in the watershed. Of the irrigated lands, the majority is sprinkler irrigated. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Sublett Creek

Sublett Creek begins in the south central mountains of Idaho in the Heglar area. The listed section of Sublett Creek is 13.26 km from the Sublett Reservoir to the “lower bounds” of the creek. Sublett Creek has been impounded for many years. An old earthen dam exists upstream from the current dam. This structure appears to have been constructed by the original homesteaders. The listed segment may have flowed to Raft River prior to the settlement of the west. However, the geology of the area makes it as likely that the creek would have subbed out in the alluvial flats of Raft River as is the current condition. Present day Sublett Creek discharges to a canal and drain system and is entirely used during the irrigation season. During the nonirrigation season Sublett Creek drains to this same system and is used for stock water, pasture water, and ground water recharge. In practice, Sublett Creek no longer exists 4 km from the reservoir. At this point all of the water is diverted into the water delivery system. DEQ’s assessment of Sublett Creek will be based upon data collected in the upper segment of the creek near the reservoir. No data were collected in the lower segments after the majority of water is contained within the delivery canals and ditches. Along this 4 kilometer course, no perennial

tributaries enter the system, although approximately 10 ephemeral systems may contribute during runoff events. The USGS has not gauged Sublett Creek. The Sublett Creek Watershed is an area of approximately 135 km². Given this size watershed, channel characteristics were extrapolated from regional curves. These regional curves are in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, Sublett Creek near the first headgate should have a mean bankfull depth of 0.67 m, a bankfull width of 10.77 m and a bankfull cross-sectional area of approximately 8.75 m². Due to the lack of gauged flow at the time of this writing, a statistical interpretation of hydrological events will be provided based upon the other gauge data located within the subbasin.

Physical Characteristics

The §303(d)-listed segment of Sublett Creek begins at the reservoir at an elevation of 1,613 m (headgate elevation). This assessed segment is 3.78 km long. The valley through which this segment flows is approximately 3.22 km in length. The segment has a very low slope of 0.86 percent. This slope corresponds to an 8.62 m fall per kilometer. Slopes of this magnitude are usually seen in moderate to highly sinuous streams that are depositional streams. However, sinuosity is classified as low (1.2) for the listed segment. This is likely the direct result of the stream being confined in the rather small valley bottom. Floodplain materials are composed of fine textured sands and small gravel derived from volcanic plateau lands in the lower bounds and sedimentary fluvial lands in the upper watershed. Consequently, it would be expected that the percent fines of Sublett Creek should be similar in comparison to a channel with low slopes, moderate sinuosity, and finer floodplain materials such as Goose Creek or Raft River. The annual hydrograph is strictly controlled by the water users and consequently bankfull measurements would not be representative of a watershed of similar size.

Hydrology

Due to the lack of data, the natural hydrology of Sublett Creek cannot be described with USGS gauge data. Additionally, the gauge data available at other locations do not correspond with data collected concurrently in Sublett Creek. The reservoir withdrawals change the shape of a normal runoff curve. Discharge corresponds more with crop requirements than with runoff events. Additionally, the whole of the Sublett drainage is highly influenced by ground water. Most of the precipitation in the area infiltrates into the karst geology of the surrounding mountains. The creeks feeding the reservoir often peak in discharge later in the summer rather than early spring (Lay 2002).

The average annual hydrograph for Sublett Creek based upon DEQ monitoring is shown in the following figure (Figure 27). It should be noted that measurements were not taken in November through March.

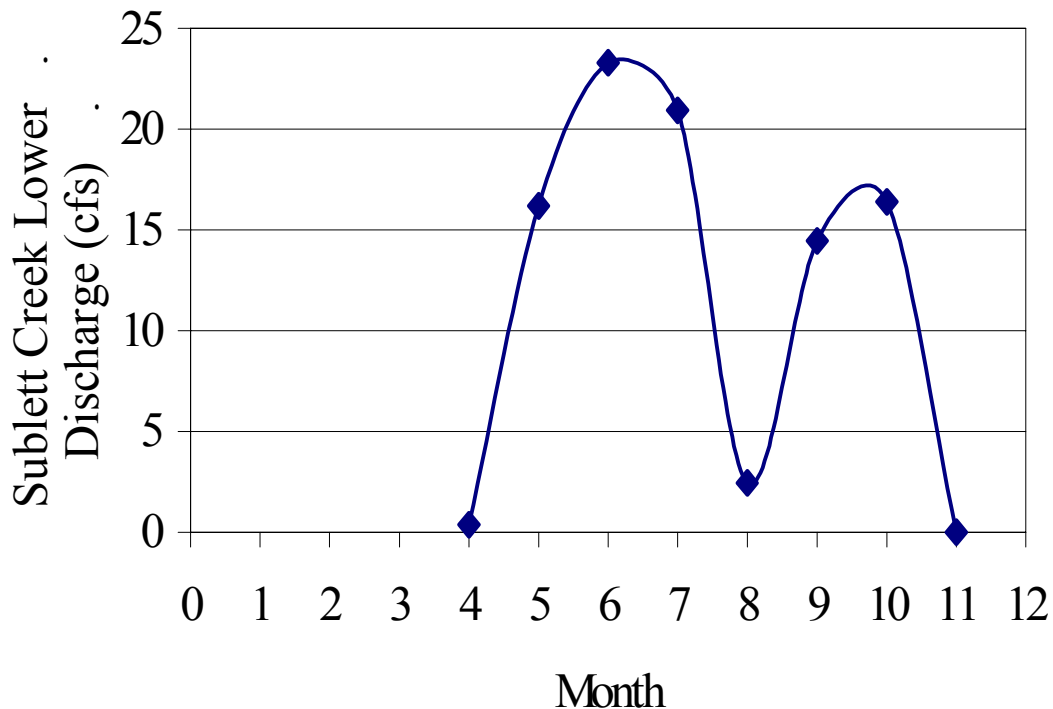


Figure 27. Sublett Creek monthly average discharge 2000-2002.

Existing Water Quality Data

Water quality samples containing a full suite of constituents collected within the listed segment of the Sublett Creek are rare. Upon a review of the STORET database no samples could be found.

DEQ sampled in the creek over the course of 2000-2001, with a few additional samples collected in 2002. Additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in some months. This sampling design was intended to determine annual pollutant loads. The annual load estimated by this type of design would overestimate the annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and in the tables and used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

One sample location was set up on the listed segment of Sublett Creek. The location was approximately 1.6 km below the reservoir (see Figure 21). Sampling began in July of 2000. The site was used to determine concentrations and loads for the stream.

Water quality data collected from the sample location reflect the high quality expected from the tailrace of a reservoir and from a primarily ground water fed system. Land use activities are not likely to influence the water quality of Sublett Creek to a great deal in the limited distance before the creek is removed from the natural channel. For example, TSS in Sublett Creek averages 7 mg/L (standard deviation 11 mg/L), which is lower than the samples collected above the reservoir at Raft River sites (15 mg/L). These samples were taken in the same day as the upper samples and include the critical periods of springtime low flows and summertime high flows. The TP is lower in Sublett Creek than Raft River as well, although the difference is less dramatic than suspended sediments. At Sublett Creek the average TP concentration was 0.055 mg/L (standard deviation 0.034 mg/L), while at the upper site the average TP concentration was 0.061 mg/L. The minimum measured TP concentration at Sublett Creek was a non detect (< 0.005 mg/L) in October and the maximum was 0.143 mg/L during the end of August following near complete draw-down of the reservoir.

Monthly concentrations of TP were never indicative of excess nutrients that may cause impairment (nuisance aquatic vegetation). Guidelines that DEQ has used in the past are not to exceed 0.160 mg/L TP in any single sample and 0.100 mg/L TP in any average monthly sample. The guidelines were never exceeded (Table 31). In addition, a lack of nuisance aquatic vegetation is seen within the system. Further chlorophyll *a* samples are required to determine a subbasin wide model for nutrient concentration and sestonic chlorophyll *a* concentrations. In addition, nitrogen compounds were also very low within the system. Nitrate plus nitrite samples averaged 0.041 mg/L (standard deviation 0.113 mg/L).

Dissolved oxygen was also monitored throughout 2000-2002. The DO never fell below state standards even following the complete diversion of Sublett Creek from up above the site. At that time, any discharge into the reach below the diversion was from seepage, a very small spring, or water leaking through the diversion structure. A fall of DO levels was expected to correspond with the decreased flow and a rise in stream temperature. However, this was not the case. Stream temperatures at that time remained near ground water temperatures, and DO levels remained relatively high (8 plus mg/L). Dissolved oxygen is often used in conjunction with pH to determine if excess nutrients have caused nuisance aquatic growths. In prior discussions, DEQ had determined that excess aquatic growths associated with excess nutrients had not occurred in Sublett Creek during the sampling period. The DO and pH data support this contention. Therefore, DEQ finds that the lower segment of Sublett Creek is not polluted with oxygen demanding materials.

Bacteria counts were very low for the most part. One sample exceeded the instantaneous criteria on September 4, 2000 (1,700 colonies/100 ml). However, follow-up monitoring was not completed to determine if water quality violation had occurred due to zero discharge from the reservoir. The proceeding day a sample was taken which was very low (6 colonies/100 ml). The following month (October 4, 2000) bacteria counts were 2 colonies/100 ml. The magnitude of the change in bacteria counts in September and October may be related to the proximity of a stock corral near the sample location. The corrals were used intermittently as a gathering point for redistribution to other areas of pasture or allotments. Due to the intermittent use it is unlikely that a month-long bacteria exceedance could occur based upon the frequent very low levels. Additionally, water to the creek had been turned off shortly after September 4, 2000. Periodic visits to the site indicated that the creek remained dry until nearly October 4. If the unusually

high data point is excluded, the average bacteria count for Sublett Creek was 19 colonies/100 ml; if the unusually high data point is included, the average is 99 colonies/100 ml with a standard deviation of 368.

From the 2001 data set, TSS also appears to be a non-factor effecting beneficial uses. The upper segment of the creek contains a medium-sized reservoir that would act as a sediment sink. Consequently, much of the sediment stored in the system is never transported out of the reach as a suspended load. In extremely low water years, the suspended fraction may increase as the reservoir is completely emptied. With these events, the stored sediments would mobilize into the lower channel as the creek cuts through the sediments stored in the old channels. However, either the stored fraction in the reservoir is low enough or the complete draw-down of the reservoir occurs on such a regular basis that increased sediment loadings never occurred following draw-down. As stated previously, TSS below the dam averaged 7 mg/L while above the dam the average was near 15 mg/L. Month-to-month variation below the dam was very low as expected below storage structures. August and September samples were nearly identical to samples collected during the spring.

Instantaneous temperature measures were also collected in Sublett Creek. In the warmer months of July and August one temperature exceedance occurred. The exceedance occurred at a time when discharge from the reservoir was zero. At other times, while the creek was diverted, what little water remained in the creek did not exceed instantaneous temperature standards. Again, this was likely due to the influence of ground water in the lower reach. Temperature is likely not an issue in Sublett Creek due to the cold water springs that feed the system. These springs would act as a temperature buffer for the system.

The overarching water quality problem in Sublett Creek is not any of the previously mentioned water quality parameters. It is simply flow alteration. Typically, any water quality guideline or standard, if it is violated, is violated when the water is shut off to the creek. Temperature, low DO, and TSS are usually the parameters associated with flow alteration problems. In Sublett Creek's case, these parameters are buffered by the upstream watersheds water source and quality. However, the beneficial uses of the creek remain impaired due to long periods of zero flow during the spring filling period and during the summer when water is not required for the crops.

It appears from the data that nutrients, suspended sediment, DO, temperature, and bacteria are within the bounds of water quality determined to be supportive of the designated beneficial uses. If the beneficial uses sustain any impact in the lower segment it is due solely to flow alteration. Consequently, DEQ will not complete a nutrient, suspended sediment, DO, temperature, or bacteria TMDL on the creek. However, DEQ will retain Sublett Creek on the §303(d) list for flow alteration in the lower segment from the reservoir to the lower bounds of the creek.

Point and Nonpoint Sources

Sublett Creek flows through the sixth field HUCs 170402100401 and 170402100402. The GIS coverages indicate that 40.29 percent of the land use is dry land farming, 44.59 percent is rangelands, 14.89 percent is irrigated, and 0.23 percent of the watershed is forested. The major sources of nonpoint source pollution in the watershed are activities associated with these land uses. The listed segment falls mainly within the rangeland land use area. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Table 31. Measured water quality constituents in Sublett Creek.

Month	No of Samples	TSS (mg/L) ^a	Total NH ₃ as N (mg/L) ^b	Total NO ₂ + NO ₃ as N (mg/L) ^c	Total P (mg/L) ^d	Temp (°C) ^e	Dissolved Oxygen (mg/L) ^f	Bacteria <i>E. coli</i> (Col/100 ml) ^g
January	0							
February	0							
March	0							
April	2	5	0.012	0.046	0.050	9.16	12.43	3
May	5	16	0.015	0.018	0.080	12.36	9.35	1
June	2	1	0.010	0.008	0.046	13.70	8.73	0
July	3	2	0.024	0.010	0.039	19.75	8.36	50
August	3	8	0.024	0.180	0.090	19.90	9.79	58
September	3	3	0.018	0.020	0.036	13.76	9.88	570
October	3	5	0.009	0.010	0.025	8.10	10.21	13
November	0							
December	0							
Annual Average		7	0.016	0.041	0.055	13.91	9.70	99
Standard Deviation		11	0.011	0.113	0.034	4.81	1.73	368

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.

b Total ammonia as nitrogen in milligrams per liter.

c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO₂+NO₃ detection limit = 0.005mg/L.

d Total phosphorus in milligrams per liter.

e Temperature in degrees Celsius.

f milligrams per liter.

g colonies per 100 milliliters.

Cassia Creek

Cassia Creek begins in the south central mountains of Idaho in the Albion mountain range. The listed section of Cassia Creek is 20.50 km from the confluence of Conner Creek to the confluence of Raft River. In 1998, the upper segment of Cassia Creek was removed from the §303(d) list. The upper segment is 18.54 km long and begins at the confluence of Flat Canyon Creek and New Canyon Creek. Present-day Cassia Creek rarely reaches the Raft River during the irrigation season. During the nonirrigation season Cassia Creek will contribute some water to the Raft River system. DEQ's assessment of the lower segment of Cassia Creek will be based upon a few data points collected from one location when there was water in the creek. This sample location was near Malta on the Hudseph cutoff road. Data collected mainly in the upper

segment of the creek near Conner Creek will be used to reassess the delisted segment. However, this data may be used to add robustness and understanding of the water quality in the lower segment as well.

Along Cassia Creek, eight perennial tributaries enter the system (Conner, Cross, Stinson, New Canyon, Flat Canyon, Clyde, and Cold Spring Creeks as well as Rice Spring), although all of these enter above the listed segment (except Rice Spring which enters within the listed segment). Additionally, many ephemeral systems may contribute during runoff events. The USGS has gauged Cassia Creek near the confluence of Stinson Creek in the upper segment. The Cassia Creek Watershed is an area of approximately 458 km². Given this size watershed, channel characteristics were extrapolated from regional curves. These regional curves are in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, Cassia Creek near Raft River should have a mean bankfull depth of 0.78 m, a bankfull width of 17.77 m and a bankfull cross-sectional area of approximately 19.08 m².

Physical Characteristics

The §303(d)-listed segment of Cassia Creek begins at Conner Creek at an elevation of 1,487 m. The listed segment is 20.50 km long. The valley through which this segment flows is approximately 18.76 km in length. The segment has a very low slope of 0.64 percent. This slope corresponds to a 6.45 m fall per kilometer. Slopes of this magnitude are usually seen in moderate to highly sinuous streams that are depositional streams. However, sinuosity is classified as low (1.1) for the listed segment. This is likely the direct result of the stream being channelized and diverted for irrigation uses for many years. Floodplain materials are composed of very fine textured sands and silts from volcanic plateau lands and volcanic fluvial lands in the lower watershed. Consequently, it would be expected that the percent fines of Cassia Creek would be similar in comparison to a channel with low slopes, moderate sinuosity, and fine floodplain materials such as Goose Creek or Raft River. The annual hydrograph is strictly controlled by the water users and consequently bankfull measurements would not be representative of a watershed of similar size.

Hydrology

Due to the lack of current data, the hydrology of Cassia Creek cannot be described with USGS gauge data. The only data available were collected in the late 1960s and 70s. Furthermore, changes in irrigation withdrawals since that time would change the shape of a normal runoff curve making a statistical relationship with other gauged watershed difficult to obtain, with weak predictive abilities. The weak relationship between the historical Cassia Creek data and similar data collect at Raft River can be seen in Figure 28. It appears that flow in Cassia Creek near the gauge varied much more while Raft River did not experienced as wide of swings in flow during the same period. As a result, the ability to predict Cassia Creek discharge using Raft River discharge is undermined. Consequently, the average annual hydrograph for Cassia Creek will be based upon the historical USGS monitoring collected (Figure 29).

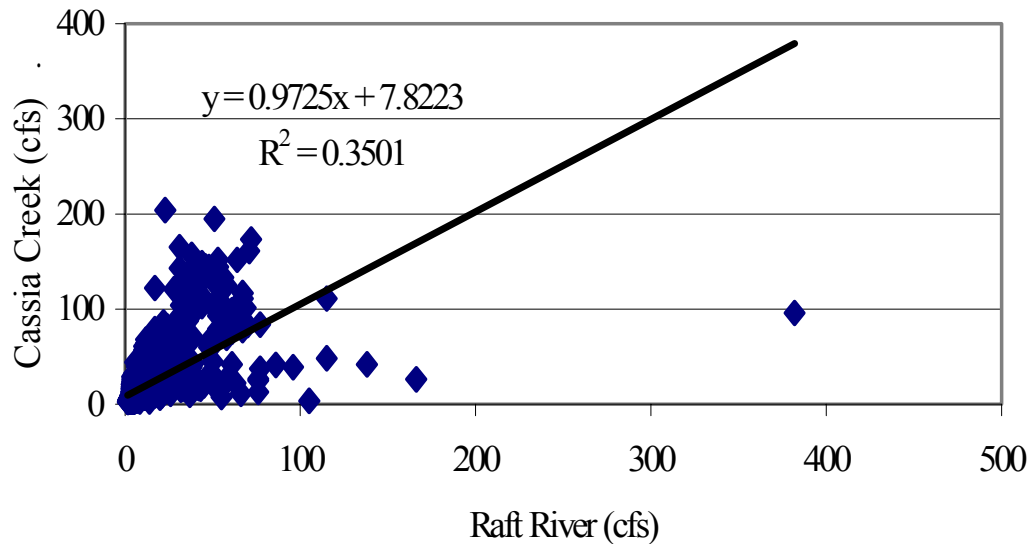


Figure 28. Linear regression model of Cassia Creek and Raft River discharge.

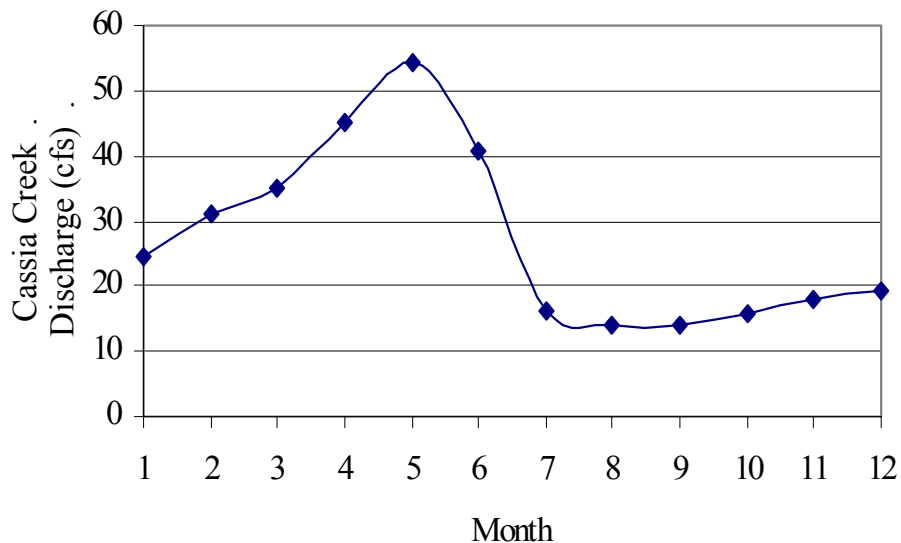


Figure 29. Annual average hydrograph for Cassia Creek based upon U.S. Geological Survey gauge data.

Existing Water Quality Data

Water quality samples containing a full suite of constituents collected within the listed segment of the Cassia Creek are rare. Upon a review of the STORET database no samples could be found.

DEQ sampled low in the listed segment creek nine times over the course of 2001-2002, and 26 times in the upper portion of the listed segment over 2000-2002. Additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the original 2001 data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in one month. This sampling design was intended to determine annual load. However, the annual load estimated by this type of design would overestimate annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and other tables and will be used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average. Water quality information was collected from the upstream portion of the listed segment to determine background concentrations and loads from the unlisted segments of the river.

The chemical constituents at both sites seemed to be very similar throughout the sampling period. In order to determine if this was the case an ANOVA was conducted to test the null hypothesis.

H_0 : Cassia Creek upper mean = Cassia Creek lower mean.

H_a : Cassia Creek upper mean \neq Cassia Creek lower mean.

Each constituent sampled at the two locations were tested using Systat 7.0. For most constituents the null hypothesis was rejected ($p < 0.05$). However, temperature, DO, pH, TDS, bacteria, and SC were not significantly different from station to station (Table 32). Therefore, for these constituents the null hypothesis was not rejected.

For the remaining constituents, the means from the lower site, located near the Hudspeth cutoff, were much higher than the upper site means near Conner Creek. The change in the remaining constituents is likely the result of increased degradation in the lower segment. The constituents most likely affected by anthropogenic disturbances are the ones that are significantly elevated. The ones not as likely to be influenced by anthropogenic disturbances, (e.g. pH and SC) are not statistically different between locations.

For the most part, the statistical tests allow DEQ to reaffirm the removal of the upper segment from the §303(d) list in 1998 as well as the action taken to retain the lower segment on the list. However, the sparse data set from the lower segment will likely lead to greater uncertainty concerning pollutant loads for that segment. In addition, the data must be presented as separate data sets. These results are presented in Tables 33 and 34.

Table 32. Analysis of variance probability values for two sample locations.

Constituent	Significance Value (p)
Temperature	0.723
Dissolved Oxygen	0.954
Specific Conductivity	0.295
pH	0.235
Total Dissolved Solids	0.315
Total Suspended Sediment	0.007
Total Ammonia	0.040
Nitrate + Nitrite	0.048
Total Phosphorus	0.037
<i>E. coli</i>	0.287

Water quality data collected from the upper sample location reflect the water quality expected from a system in which aquatic life beneficial uses are fully supported. However, at this upper location, nutrients are on the verge of concentrations seen in systems in which the beneficial uses are impaired. Land use activities are beginning to change from rangeland uses to uses of irrigated agriculture and riparian pasture. Some constituents increase dramatically from segment to segment. For example, TSS in upper Cassia Creek averages 21 mg/L (standard deviation 29 mg/L), which is much lower than the samples collected in the lower segment (104 mg/L, standard deviation 135 mg/L). These samples were taken on the same day. There is a dramatic difference in TP concentrations as well, almost as dramatic as the difference in suspended sediments. At upper Cassia Creek the average TP concentration was 0.110 mg/L (standard deviation 0.061 mg/L), while at the lower site the average TP concentration was 0.215 mg/L average.

Monthly concentrations of TP at both sites were indicative of excess nutrients that may cause impairment (nuisance aquatic vegetation). Guidelines that DEQ has used in the past are not to exceed 0.160 mg/L TP in any single sample and 0.100 mg/L TP in any average monthly sample. The guidelines were almost always exceeded (see Tables 33 and 34). However, an assessment of nuisance aquatic vegetation was never made within the system. Further chlorophyll *a* samples are required to determine a subbasin wide model for nutrient concentration and sestonic chlorophyll *a* concentrations. Nitrogen compounds were elevated at both locations within the system. Nitrate plus nitrite samples at the upper location averaged 0.189 mg/L (standard deviation 0.068 mg/L).

Dissolved oxygen was also monitored at both locations. Dissolved oxygen never fell below state standards even following the complete diversion of Cassia Creek. A fall of DO levels was expected to correspond with the decreased flow and a rise in stream temperature. However, this was not the case. Stream temperatures at that time remained near ground water temperature and DO levels remained relatively high (8 mg/L plus). The relatively stable temperatures and DO levels indicate a strong influence of ground water in the hydrology of Cassia Creek.

Table 33. Monthly average water quality constituents in lower Cassia Creek.

Month	No of Samples	TSS (mg/L) ^a	Total NH ₃ as N (mg/L) ^b	Total NO ₂ + NO ₃ as N (mg/L) ^c	Total P (mg/L) ^d	Temp (°C) ^e	Dissolved Oxygen (mg/L) ^f	Bacteria <i>E. coli</i> (Col/100 ml) ^g
January								
February								
March								
April	1	60	0.034	0.297	0.131	7.61	10.29	130
May	4	147	0.055	0.104	0.282	12.24	9.44	1469
June	1	76	0.029	0.139	0.187	11.42	8.58	980
July	dry							
August	dry							
September	dry							
October	dry							
November	1	2	0.010	0.005	0.058	5.63	13.5	25
December								
Average		104	0.042	0.123	0.215	10.63	9.84	999
Standard Deviation		135	0.049	0.096	0.214	2.85	1.64	1766

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.

b Total ammonia as nitrogen in milligrams per liter.

c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO₂+NO₃ detection limit = 0.005mg/L.

d Total phosphorus in milligrams per liter.

e Temperature in degrees Celsius.

f milligrams per liter.

g colonies per 100 milliliters.

Table 34. Monthly average water quality constituents in upper Cassia Creek.

Month	No of Samples	TSS (mg/L) ^a	Total NH ₃ as N (mg/L) ^b	Total NO ₂ + NO ₃ as N (mg/L) ^c	Total P (mg/L) ^d	Temp (°C) ^e	Dissolved Oxygen (mg/L) ^f	Bacteria <i>E. coli</i> (Col/100 ml) ^g
January								
February								
March								
April	2	41	0.029	0.272	0.112	6.05	11.61	265
May	5	49	0.025	0.179	0.154	7.71	10.04	934
June	3	22	0.014	0.097	0.108	8.95	10.05	473
July	2	6	0.023	0.145	0.091	14.09	8.565	500
August	5	16	0.021	0.222	0.109	15.09	8.99	396
September	3	5	0.021	0.248	0.100	10.39	9.69	673
October	3	4	0.011	0.187	0.080	8.44	10.08	178
November	1	8	0.016	0.091	0.061	4.65	12.10	39
December								
Average		21	0.020	0.189	0.110	10.10	9.87	541
Standard Deviation		29	0.008	0.068	0.061	3.88	1.53	724

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.

b Total ammonia as nitrogen in milligrams per liter.

c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO₂+NO₃ detection limit = 0.005mg/L.

d Total phosphorus in milligrams per liter.

e Temperature in degrees Celsius.

f milligrams per liter.

g colonies per 100 milliliters.

Bacteria counts were very high at both locations. The instantaneous criterion (576 colonies/100 ml) was violated multiple times in both segments. However, follow-up monitoring was not completed after each violation. After the one of the first exceedances, follow-up monitoring did take place. The geometric mean of the five samples collected within the 30-day period equaled 173. The criterion for exceedance is 125. Budget constraints did not allow for further follow-up monitoring after subsequent bacteria violations in the upper location.

At the lower location, following an instantaneous bacteria criteria violation, DEQ attempted to determine if water quality violations had occurred. Subsequent samples could not be collected as the creek was dewatered during the 30-day period. However, the geometric mean of the five closest samples (all of the 2001 data) resulted in a geometric mean of 158, suggestive that bacteria are a continual problem within the lower segment.

From the upper data set, TSS appears to be a non-factor effecting beneficial uses, while the opposite is true for the lower segment. The upper segment of the creek contains a well-developed riparian zone that would act as a sediment buffer from land use activities in the uplands. Consequently, much of the sediment stored in the uplands is never transported to the reach. In the upper reach, TSS has an annual average of 21 mg/L. Additionally, the suspended sediment criteria established in other TMDLs (50 mg/L monthly average, 80 mg/L daily maximum) were never exceeded in the upper location.

In the lower reach, the riparian zone is less developed and land use activities occur closer to the stream system. In extremely low water years, the suspended fraction may decrease as the less hydraulic bank interaction occur. With increased events the stored sediments would mobilize into the lower channel as the creek cuts through the sediments stored in the old channels. As seen in Table 33, TSS in the lower section averaged 104 mg/L, while in the upper reach the average was near 21 mg/L.

Instantaneous temperature measurements were also collected in Cassia Creek. In the lower reach water is completely diverted before the warmer months of the summer. No exceedances were noted. Temperature is likely not an issue in Cassia Creek due to the complete diversion of water in most months of the year.

The overarching water quality problem in Cassia Creek is not any of the previously mentioned water quality parameters. It is simply flow alteration. Typically, any water quality guideline or standard, if it is violated, is violated when the water is shut off to the creek. Temperature, low DO, and TSS are usually the parameters associated with flow alteration problems. In Cassia Creek's case, these parameters are buffered by the upstream watersheds water source and quality. However, the beneficial uses of the creek remain impaired due to long periods of zero flow during the spring filling period and during the summer when water is not required for the crops.

It appears from the data that DO and temperature are within the bounds of water quality determined to be supportive of the designated beneficial uses. The beneficial uses sustain impact in the lower segment from flow alteration, habitat alteration, nutrients, bacteria and sediment. Consequently, DEQ will complete nutrient, bacteria, and suspended sediment TMDLs on the creek. Furthermore, DEQ will include the upper segments of Cassia Creek in the bacteria and nutrient TMDLs. Additionally Cassia Creek will remain on the §303(d) list for flow alteration and habitat alteration in the lower segment from Conner Creek to Raft River.

Point and Nonpoint Sources

Cassia Creek flows through the fifth field HUCs 1704021010, 1704021020, and 1704021021. The GIS coverages indicate that 86.1 percent is rangeland, 11.3 percent is forested, and 2.6 percent is irrigated. The major sources of nonpoint source pollution in the watershed are activities associated with these land uses. The listed segment contains most of the irrigated land uses within the watersheds. Additional sediment sources include unstable banks and reentrainment from the streambed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Fall Creek

Fall Creek begins in the south central mountains of Idaho in the Heglar area. The listed section of Fall Creek is 4.75 km in length, encompassing an area from the headwaters to Lake Fork

Creek. The karst geology of the area greatly influences the hydrology of Fall Creek. Rapid infiltration of precipitation occurs throughout the watershed. This water is stored in the local aquifers and arises in a few large springs scattered throughout the watershed. Fall Creek originates at Upper Fall Creek Spring nearly 1 km from the headwater area. The creek channel above this spring is dry during most of the year.

The creek was originally listed in 1998 following BURP protocols and guidance in the Water Body Assessment (WBAG) version I (DEQ 1996). The creek is listed with unknown pollutants. The original listing criteria for Fall Creek are in question. The macroinvertebrate index used for the 1998 listing cycle had cutoff criteria for not full support at 2.5 and full support at 3.5 (an index score of less than 2.5 indicates the beneficial uses are not being supported; a score of over 3.5 indicates the uses are being supported). The Fall Creek scored a 3.48. An index score such as this would fall into the needing verification area. The habitat index score for Fall Creek was also relatively high for the Snake River Basin. The score was approximately 81 percent of the reference score. Given two moderately high index scores Fall Creek should not have been listed as not supporting its beneficial uses. Rather it should have been placed in the category of needing verification and the listing criteria would have been based upon other parameters. In addition, salmonid spawning appears to be fully supported (two plus size classes of salmonids plus young-of-year salmonids) under the WBAG version I guidelines. The only water temperature collected at that time on Fall Creek was at 12.5 °C. This would also have not precipitated a listing.

Under the WBAG version II guidelines (Grafe et al. 2002), Fall Creek would receive full support status. The fish index score equaled three (range 0-3), the habitat index equaled three (range 0-3) and the macroinvertebrate index score was 1 (range 0-3). The average of the three indices was 2.33. Any average score above two is considered fully supporting the aquatic life beneficial uses (DEQ 2002). Thus, it appears that Fall Creek was listed erroneously. However, DEQ will proceed with the assessment of the water chemistry collected to date on Fall Creek to determine if any water quality standards or guides are indicative of impaired beneficial uses.

DEQ's assessment of Fall Creek will be based upon data collected in the lower segment of the creek approximately 1.6 km from the confluence of Lake Fork Creek. No data were collected in the lower segment closer to the confluence. The watershed above the sample location is isolated from much of the normal human activity in the watershed due to a road closure at the sampling location. Along the stream course, no perennial tributaries enter the system although many ephemeral systems may contribute during runoff events. The USGS has not gauged Fall Creek. The Fall Creek Watershed is an area of approximately 8.29 km². Given this size watershed, channel characteristics were extrapolated from regional curves. These regional curves are in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, Fall Creek near the confluence with Lake Fork Creek should have a mean bankfull depth of 0.62 m, a bankfull width of 8.04 m and a bankfull cross-sectional area of approximately 8.75 m².

Physical Characteristics

The §303(d)-listed segment of Fall Creek begins above Fall Creek Spring at an elevation of 1,926 m (1,829 m spring elevation). The valley through which this segment flows is approximately 4.57 km in length. The segment has a very moderate slope of 1.72 percent. This slope corresponds to a 17.21 m fall per kilometer. Slopes of this magnitude are usually seen in moderate to low sinuous streams that are mixed erosional and depositional streams. However, sinuosity is classified as very low (1.0) for the listed segment. This is likely the direct result of the stream being confined in the rather small valley bottom. Floodplain materials are composed

of fine textured sands and small gravel derived from sedimentary fluvial lands. It would be expected that the percent fines of Fall Creek would be similar in comparison to a channel with moderate slopes, moderate sinuosity, and finer floodplain materials such as Sublett Creek. The annual hydrograph is highly influenced by the karst geology of the limestone mountains of the Heglar area. As a result, annual peaks in the hydrograph are not associated with normal runoff timing. Local residents and DEQ personnel observations indicate that peak flows occur in mid to late summer.

Hydrology

Due to the lack of data, the natural hydrology of Fall Creek cannot be described with USGS gauge data. Additionally, the gauge data available in other watersheds do not have a statistical relationship with data collected concurrently in Fall Creek. The geology and infiltration rates of the surrounding watershed change the shape of a normal runoff curve. The discharge does not correspond well with normal snowmelt runoff or precipitation events. Additionally, the whole of the Fall Creek drainage is highly influenced by ground water (see Sublett Creek hydrology discussion). The average annual hydrograph for Fall Creek based upon DEQ monitoring is shown in the following figure (Figure 30). It should be noted that measurements were not taken in all months (December through March). Additionally, it appears that Fall Creek consistently averages near 1 cubic feet per second (cfs) year-round with minimum fluctuations around this average.

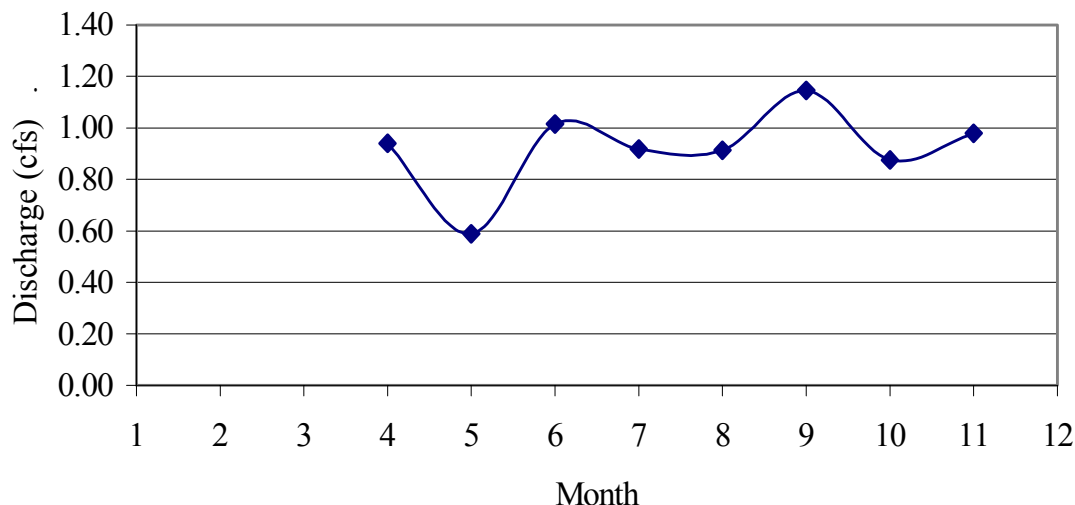


Figure 30. Fall Creek monthly average (April-November) discharge 2000-2002.

Existing Water Quality Data

Water quality samples containing a full suite of constituents collected within the listed segment of Fall Creek are rare. Upon a review of the STORET database no samples could be found.

DEQ sampled in the creek over the course of 2000-2001, with a few additional samples collected in 2002. Additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the original 2001 data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a

limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in one month. This sampling design was intended to determine annual load. However, the annual load estimated by this type of design would overestimate annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and other tables and will be used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

One sample location was set up on the listed segment of Fall Creek. The location was approximately 1.6 km above the confluence with Lake Fork Creek. Sampling began in July of 2000 (see Figure 21). The site was used to determine concentrations and loads for the stream.

Water quality data collected from the sample location reflect the high quality expected from primarily a ground water driven system. Land use activities are not likely to influence the water quality of Fall Creek to a great deal in the limited distance before the creek reaches Lake Fork Creek. Therefore, the sample location should be indicative of the overall water quality of the stream. The water chemistry collected from the stream appears to corroborate the biotic assessments in the early months of the year. However, following changes in land use, the water chemistry of Fall Creek changes dramatically. Nearly all constituents are extremely elevated and exceed water quality standards and guidelines. For example, TSS in Fall Creek averages less than 10 mg/L in the spring and early summer and nearly 30 mg/L in the late summer and fall. As mentioned earlier, flows are not much different between these two periods. Total phosphorus concentrations also follow this pattern, though to a much greater extent. In the spring and early summer TP concentrations are near 0.060 mg/L while in the late summer and fall they are near 0.200 mg/L which is highly elevated in comparison with EPA guidelines and other creeks within the subbasin.

Monthly concentrations of TP are indicative of excess nutrients that may cause impairment (nuisance aquatic vegetation). Guidelines that DEQ has used in the past are not to exceed 0.160 mg/L TP in any single sample and 0.100 mg/L TP in any average monthly sample. The guidelines were exceeded August-November (Table 35). Furthermore, nuisance aquatic vegetation (water crest mats covering the creek channel) is seen within the system. Further chlorophyll *a* samples are required to determine a subbasin-wide model for nutrient concentration and sestonic chlorophyll *a* concentrations. In addition, nitrogen compounds were also elevated within the system. Nitrate plus nitrite samples were near 0.550 plus mg/L in the late summer to fall.

Dissolved oxygen was also monitored throughout 2000-2002. Dissolved oxygen never fell below state standards even during the late summer and fall period when the other constituents underwent rapid increases. Stream temperatures at that time remained near ground water temperatures and DO levels remained relatively high (8 plus mg/L). Dissolved oxygen is often used in conjunction with pH to determine if excess nutrients have caused nuisance aquatic growths. In prior discussions, DEQ had determined that excess aquatic growths associated with excess nutrients had occurred in Fall Creek during the sampling period. However, the type of aquatic vegetation is more similar to that found in springs than creeks, so changes in DO levels may not respond as they would in a more typical stream with more filamentous algae.

Table 35. Measured water quality constituents in Fall Creek.

Month	No of Samples	TSS (mg/L) ^a	Total NH ₃ as N (mg/L) ^b	Total NO ₂ + NO ₃ as N (mg/L) ^c	Total P (mg/L) ^d	Temp (°C) ^e	Dissolved Oxygen (mg/L) ^f	Bacteria <i>E. coli</i> (Col/100 ml) ^g
January	0							
February	0							
March	0							
April	2	6	0.011	0.411	0.052	11.64	11.20	21
May	5	5	0.009	0.257	0.058	12.57	9.69	12
June	2	2	0.005	0.250	0.063	10.90	8.27	44
July	3	1	0.020	0.440	0.060	12.79	8.20	673
August	5	24	0.063	0.572	0.217	13.61	8.13	1964
September	3	30	0.030	0.571	0.216	14.45	7.96	956
October	3	26	0.011	0.529	0.191	9.20	9.58	221
November	1	30	0.018	0.552	0.185	11.30	9.81	130
December	0							
Annual Average		15	0.025	0.443	0.133	12.36	8.96	653
Standard Deviation		17	0.027	0.154	0.099	1.90	1.68	1442

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.

b Total ammonia as nitrogen in milligrams per liter.

c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO₂+NO₃ detection limit = 0.005mg/L.

d Total phosphorus in milligrams per liter.

e Temperature in degrees Celsius.

f milligrams per liter.

g colonies per 100 milliliters.

Bacteria counts were very low throughout the early part of the year. However, samples collected after July were typically very high. Instantaneous criteria were exceeded in July, August, and September. However, follow-up monitoring was not completed to determine if a water quality violation had occurred. Given the magnitude of the early instantaneous violations and the duration (three months) of the instantaneous violations, DEQ feels it is safe to assume that bacteria counts are sufficient to warrant a TMDL.

From the data set, TSS appears to be a non-factor effecting beneficial uses. However, the data do indicate that the changes in land use in the late summer have the potential to degrade beneficial uses. As with the other measured constituents, TSS begin to elevate in August and remains elevated through at least November. Although the levels during the elevated period are not considered harmful to the beneficial uses (i.e., they are below 50 mg/L), they do warrant

some level of concern. Continued changes could lead to a rapid unraveling of the system in high water years. At this time, DEQ feels that a TMDL for nutrients may alleviate the need for concern. Additional monitoring throughout the TMDL development stage and implementation phase will address the needs concerning TSS in Fall Creek.

Instantaneous temperature measures were also collected in Fall Creek. No temperature exceedances occurred. Rarely did the creek approach 15 °C even in the warmer months of July and August. Temperature is likely not an issue in Fall Creek due to the cold water springs that feed the system. These springs act as a temperature buffer for the system.

It appears from the data that suspended sediment, DO, and temperature are within the bounds of water quality determined to be supportive of the designated beneficial uses. If the beneficial uses sustain any impact in the segment it is due to bacteria and nutrients. Consequently, DEQ will complete bacteria and nutrient TMDLs on the creek.

Point and Nonpoint Sources

Fall Creek flows through sixth field HUC 170402100403, which is the Lake Fork Creek Watershed. The GIS coverages indicate that 100 percent of the land use is rangelands. The major source of nonpoint source pollution in the watershed are activities associated with this land use. The listed segment may also be influenced by recreation activities along the roaded portion of the watershed. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Lake Fork Creek

Lake Fork Creek begins in the south central mountains of Idaho in the Heglar area. Lake Fork Creek is not currently §303(d) listed. However, since Lake Fork Creek empties into Sublett Reservoir and Sublett Reservoir is §303(d) listed, an assessment of the water quality of Lake Fork Creek will be completed. Lake Fork Creek is 9.45 km long from the headwaters to Sublett Reservoir. The karst geology of the area greatly influences the hydrology of Lake Fork Creek. Rapid infiltration of precipitation occurs throughout the watershed. This water is stored in the local aquifers and arises in a few large springs scattered throughout the watershed. Lake Fork Creek actually originates at Upper Lake Fork Creek Spring, Moonshine Spring, and Lake Fork Springs nearly two kilometers from the watershed headwater area. The creek channel above these springs is dry during most of the year.

Following BURP protocols and guidance in WBAG version I (DEQ 1996), the creek was not listed. The macroinvertebrate index used for the 1998 listing cycle had cutoff criteria for not full support at 2.5 and full support at 3.5. Lake Fork Creek scored a 3.65. An index score such as this would put Lake Fork into the full support area. The habitat index score was also relatively high for the Snake River Basin. Given two moderately high index scores Lake Fork Creek was not listed. Under the new water body assessment guidelines Lake Fork Creek would also have received full support status. The fish index score equaled three (possible score range 0-3), the habitat index equaled three (possible score range 0-3) and the macroinvertebrate index score was 3 (possible score range 0-3). The average of the three indices was three. Any average score above two is considered fully supporting the aquatic life beneficial uses (Grafe et al 2002).

DEQ's assessment of Lake Fork Creek will be based upon data collected in the lower segment of the creek near the confluence with the reservoir. The watershed above the sample location is

well traveled, has many unimproved camping locations, and has normal rangeland activities. Along the stream course, two perennial tributaries enter the system (Van Camp Creek and Fall Creek), along with many ephemeral systems that may contribute during runoff events. The USGS has not gauged Lake Fork Creek. The Lake Fork Creek Watershed is an area of approximately 35.20 km². Given this size watershed, channel characteristics were extrapolated from regional curves. These regional curves are in *Applied River Morphology* (Rosgen 1996). Extrapolating from the regional curve, Lake Fork Creek near the confluence with Sublett Reservoir should have a mean bankfull depth of 0.63 m, a bankfull width of 8.63 m and a bankfull cross-sectional area of approximately 5.57 m².

Physical Characteristics

Lake Fork Creek begins above Lake Fork Creek Spring at an elevation of 1,987 m (1,829 m spring elevation). The valley through which this segment flows is approximately 8.82 km in length. The segment has a relatively steep slope of 3.81 percent. This slope corresponds to a 38.14 m fall per kilometer. Slopes of this magnitude are usually seen in A-type channels with low sinuosity that are erosional in nature. Sinuosity is also classified as low (1.1) for the stream. This is likely the direct result of the stream being confined in the rather small valley bottom. Floodplain materials are composed of fine textured sands and small gravel derived from sedimentary fluvial lands. It would be expected that the percent fines of Lake Fork Creek would be similar in comparison to a channel with moderate slopes, moderate sinuosity, and finer floodplain materials such as Sublett Creek. The annual hydrograph is highly influenced by the karst geology of the limestone mountains of the Heglar area. Precipitation events and snowmelt are more likely to infiltrate into the groundwater system than be expressed in the surface water system. As a result, annual peaks in the hydrograph are not associated with normal runoff timing. Local residents and DEQ personnel observations indicate that peak flows occur in mid to late summer. These peak flows are derived from the groundwater sources and may be the result of the annual snowmelt recharge reaching the surface system during the late summer.

Hydrology

Due to the lack of data, the natural hydrology of Lake Fork Creek cannot be described with USGS gauge data. Additionally, the gauge data available from other watersheds does not correlate with data collected concurrently in Lake Fork Creek. Consequently, a statistical approach to developing an annual hydrograph cannot be used. The geology and infiltration rates of the surrounding watershed change the shape of a normal runoff curve. Discharge does not correspond well with normal snowmelt runoff or precipitation events. Additionally, the whole of the Lake Fork Creek drainage is highly influenced by ground water (see Sublett Creek hydrology discussion). The average annual hydrograph for Lake Fork Creek based upon DEQ monitoring is shown in the following figure (Figure 31). It should be noted that measurements were not taken in December through March. It appears that Lake Fork Creek varies consistently between 1 and 1.50 cfs year round with minimum fluctuations around this average (average 1.26 cfs with a standard deviation of 0.52).

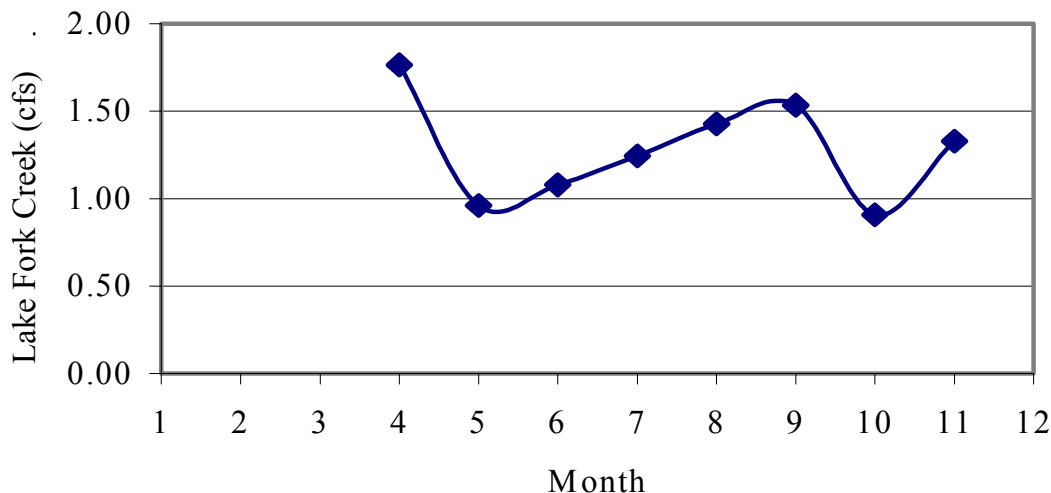


Figure 31. Lake Fork Creek monthly average discharge April through November 2000-2002.

Existing Water Quality Data

Water quality samples containing a full suite of constituents collected in Lake Fork Creek are rare. Upon a review of the STORET database no samples could be found.

DEQ sampled in the creek over the course of 2000-2001, with a few additional samples collected in 2002. The creek was sampled to address the needs of the §303(d) listed reservoir downstream. Additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the original 2001 data set, DEQ's confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in one month. This sampling design was intended to determine annual load. However, the annual load estimated by this type of design would overestimate annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables while period of record averages are presented in the text and other tables and will be used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

One sample location was set up on Lake Fork Creek. The location was near the confluence with Sublett Reservoir. Sampling began in July of 2000 (see Figure 21). The site was used to determine concentrations and loads for the stream.

Water quality data collected from the sample location reflect the high quality expected from primarily a ground water driven system. Land use activities are similar to the upper segment of Sublett Creek. A well-traveled road exists along much of the creek. Dispersed campsites are also located along the creek corridor. Rangeland activities also occur throughout the watershed. As the sample location is near the bottom of the watershed, the water quality should capture all of the land use activities located within the watershed. The water chemistry collected from the stream appears to corroborate the biotic assessments.

Nearly all constituents were at normal to low levels and rarely exceeded water quality standards and guidelines. For example, TSS in Lake Fork Creek averaged less than 13 mg/L (16 mg/L standard deviation) for the period of record. A single sample was collected above 50 mg/L throughout the entire study. However, this single sample did not exceed the recommended daily maximum of 80 mg/L set in other approved TMDLs within the Twin Falls Region. As mentioned earlier, flows are not much different between months and seasons in Lake Fork Creek.

Monthly concentrations of TP are indicative of excess nutrients that may cause impairment (nuisance aquatic vegetation) in the downstream reservoir. The TP concentrations are variable and high enough that impairment to Lake Fork Creek could be possible if other parameters were elevated as well. Guidelines that DEQ has used in the past for protection of the downstream water body are not to exceed 0.080 mg/L TP in any single sample and 0.050 mg/L TP in any average monthly sample. The guidelines for Lake Fork Creek itself would be similar to other streams in the subbasin that do not flow to a lake or reservoir (e.g. Fall Creek). The guidelines for protection of the reservoir were exceeded seven of the eight months in which samples were collected (Table 36). The guidelines for the water quality of Lake Fork Creek are exceeded half of the time. However, nuisance aquatic vegetation isn't typically seen within the system. Although, some water crest mats do exist within the creek channel typical of a spring system with low annual flushing flows. Further chlorophyll *a* samples are required to determine a subbasin-wide model for nutrient concentration and sestonic chlorophyll *a* concentrations. In addition, nitrogen compounds were only slightly elevated in comparison with other systems within the subbasin. Nitrate plus nitrite samples were near 0.200 mg/L in the late summer to fall.

Dissolved oxygen was also monitored throughout 2000-2002. Dissolved oxygen never fell below state standards even during the late summer and fall period. Stream temperatures at that time remained near ground water temperatures and DO levels remained relatively high (8 plus mg/L). Dissolved oxygen is often used in conjunction with pH to determine if excess nutrients have caused nuisance aquatic growths. In prior discussions, DEQ had determined that excess aquatic growths associated with excess nutrients had not occurred in Lake Fork Creek during the sampling period. The type of aquatic vegetation present is more similar to springs than creeks, and changes in DO levels may not respond as they would in a more typical stream with more filamentous algae.

Bacteria counts were very low throughout the early part of the year. However, samples collected after July were typically higher. Instantaneous criteria were exceeded once in August. However, follow-up monitoring was not completed to determine if a water quality violation had occurred. The instantaneous violation appears to have been an isolated event. Samples collected within the same month were low and the following month samples were even lower (the proceeding month's data are not available). However, due to the potential for bacteria contamination, as seen in other systems within the subbasin, DEQ will continue to monitor bacteria concentrations throughout the TMDL development phase. At this time, DEQ feels that a TMDL for nutrients may alleviate the need for concern, as the implementation strategies would be similar for both nutrients and bacteria given that rangeland activities are the most prevalent land use. Additional monitoring throughout the TMDL development stage and implementation phase will address the needs concerning bacteria in Lake Fork Creek.

Table 36. Measured water quality constituents in Lake Fork Creek.

Month	No of Samples	TSS (mg/L) ^a	Total NH ₃ as N (mg/L) ^b	Total NO ₂ + NO ₃ as N (mg/L) ^c	Total P (mg/L) ^d	Temp (°C) ^e	Dissolved Oxygen (mg/L) ^f	Bacteria <i>E. coli</i> (Col/100 ml) ^g
January	0							
February	0							
March	0							
April	2	32	0.025	0.168	0.153	11.51	10.01	8
May	5	23	0.014	0.147	0.102	15.32	8.51	8
June	2	3	0.010	0.078	0.046	10.52	9.32	12
July	2	6	0.007	0.005	0.065	16.49	8.38	141
August	5	8	0.012	0.050	0.120	16.82	8.90	260*
September	3	10	0.014	0.142	0.084	14.92	8.92	69
October	3	8	0.012	0.257	0.092	9.46	9.68	90
November	1	8	0.016	0.311	0.094	10.60	11.37	44
December	0							
Annual Average		13	0.013	0.131	0.098	13.98	9.11	95
Standard Deviation		16	0.007	0.136	0.051	3.39	1.26	138

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.

b Total ammonia as nitrogen in milligrams per liter.

c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO₂+NO₃ detection limit = 0.005mg/L.

d Total phosphorus in milligrams per liter.

e Temperature in degrees Celsius.

f milligrams per liter.

g colonies per 100 milliliters.

From the data set, TSS appears to be a non-factor effecting beneficial uses. However, it does indicate that Lake Fork Creek may experience a more typical annual hydrograph. Total suspended sediment is slightly elevated in the spring during what little runoff is generated in the watershed. Following this period, TSS drops dramatically for the remainder of the year. The levels during the elevated period are not considered harmful to the beneficial uses (i.e., below 35 mg/L).

Instantaneous temperature measures were also collected in Lake Fork Creek. No temperature exceedances occurred. Rarely did the creek approach 15 °C even in the warmer months of July and August. Temperature is likely not an issue in Lake Fork Creek due to the cold water springs that feed the system. These springs would act as a temperature buffer for the system.

It appears from the data that suspended sediment, DO, and temperature are within the bounds of water quality determined to be supportive of the designated beneficial uses. If the beneficial uses sustain any impact it is due to nutrients and possible bacteria. Consequently, DEQ will complete a nutrient TMDL on the creek and continue to monitor bacteria concentrations.

Point and Nonpoint Sources

Lake Fork Creek flows through sixth field HUC 170402100403, which is the Lake Fork Creek Watershed. The GIS coverages indicate that 100 percent of the land use is rangelands. The major sources of nonpoint source pollution in the watershed comes are these land uses. The listed segment may also be influenced by recreation activities along the roaded portion of the watershed. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

Sublett Reservoir

Sublett Reservoir lies within the Heglar mountains of Idaho in an area east of the towns of Sublett and Malta. The major sources of water for the reservoir are Lake Fork Creek and Sublett Creek. At full pool, the reservoir covers approximately 39 hectares. The Sublett Canal Company operates a nonrecording weir below the reservoir. The Sublett Reservoir watershed is an area of approximately 114 km². Almost all of the nearly 1,039 acre-feet is in the usable storage pool. The crest of the spillway is at 5,335 ft. The reservoir has an earthen spillway that would be damaged if water were allowed to spill. Through water management, the reservoir fills each year but does not require spilling water through any water conveyance system other than the current canal system. Based on crop demands, the water level in Sublett Reservoir may fluctuate up and down several times throughout the irrigation season year (Lay 2003).

Physical Characteristics

The reservoir has an overall length of 1.32 km and an effective length of 1.08 km through the Lake Fork Creek arm. The maximum width is 0.40 km while the average width is 0.21 km. Shoreline development is low at 1.97 (a perfectly round lake would have a shoreline development of 1.0, while a highly dendritic lake would have much higher shoreline development). For comparison, Lake Mead has a shoreline development of 9.72, Salmon Falls Reservoir 5.32, and the third lake of the Independence Lakes has a shoreline development of 1.03. The maximum depth measured by DEQ in the year 2001 was 10 m with a mean depth of 3.29 m (mean depth = volume [m³]/ surface area [m²]).

Hydrology

The hydrology of Sublett Reservoir can best be described by a summation of Lake Fork Creek and Sublett Creek data. To estimate how much water enters the reservoir, DEQ averaged each month's data for Lake Fork and Sublett Creeks. In any month in which zero data were collected, the annual average was used for that month. This process will likely overestimate the amount of water entering the reservoir. The annual average input ranged from nearly 4 cfs in Sublett Creek to 1.25 cfs in Lake Fork Creek (Figure 32).

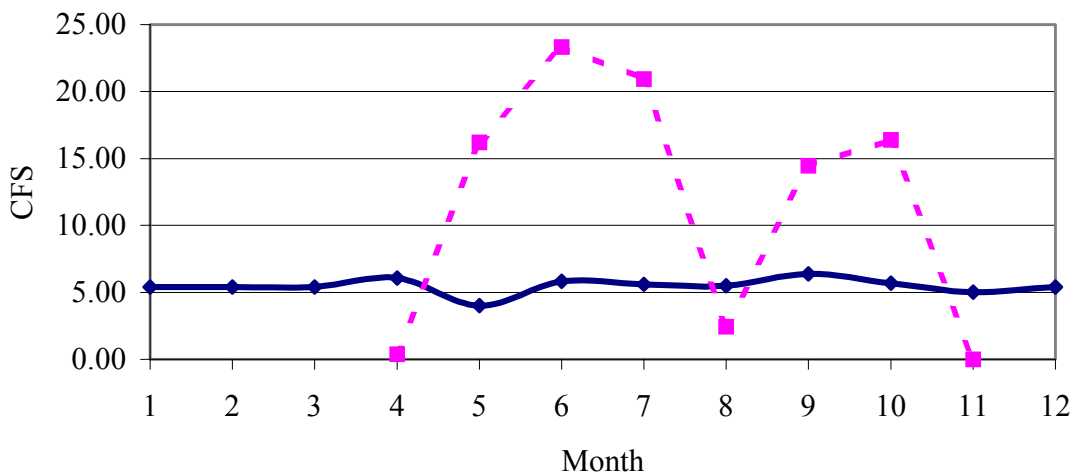


Figure 32. Annual average hydrograph for the reservoir input (solid line) and output (dashed line).

Fisheries

Idaho Department of Fish and Game stocking records indicate that numerous species of fish have been stocked into Sublett Reservoir since 1967. Predominantly rainbow and cutthroat trout are placed into the water body. Fish and Game records indicate that “other” salmon and “other” trout were stocked from the early 1970s until the early 90s. Kokanee and brown trout are captured by sportsmen from the reservoir regularly. Typically, one strain or another of rainbow or cutthroat trout are stocked each year up to several times per year and range from fry to catchable sizes. Therefore, DEQ assumes that any salmonids captured in Sublett Reservoir are from stocked populations (brown trout are likely naturalized populations that spawn in Sublett or Lake Fork Creeks). Idaho Department of Fish and Game have, over the past 10 years, managed the reservoir under their general category.

Macroinvertebrates

DEQ collected macroinvertebrates in Sublett Reservoir one time in 1997. Macroinvertebrates were collected in three general locations and pooled for analysis. The first location was near the boat launching area near the Sublett Creek inlet, the second was in the Lake Fork Creek inlet, and the third was near the dam. Few macroinvertebrates were collected in the pooled samples. Overall, the community consisted of chironomids and oligochaete worms. An assessment of the water quality based on the macroinvertebrate community is unlikely due to poor sample collection of macroinvertebrates statewide and a lack of a reference community to compare to. However, the macroinvertebrate community in Sublett Reservoir appears similar to oligotrophic lakes and reservoirs.

Aquatic Vegetation

Emergent aquatic vegetation such as milfoil (*Myriophyllum* sp.) and pondweed (*Potamogeton amplifolius*) is common in the very clear waters of Sublett Reservoir. However, some of the primary production comes from algal cells within the reservoir. DEQ collected phytoplankton in 1997 to determine the composition of the algae in the reservoir. At that time, the phytoplankton community consisted of five groups, green algae, diatoms, yellow-green algae, blue-green algae,

and a group of “uncertain classification.” Typically, blue-green algae dominate highly eutrophic systems. In Sublett Reservoir, the blue-greens made up only 18.15 percent of the biovolume, while diatoms and green algae made up 58.10 percent of the biovolume. As another indicator of trophic state, chlorophyll *a* samples were collected throughout the year to determine if nuisance conditions existed. For lakes, Carlson’s trophic state index (TSI) can be used to determine if a lake is undergoing cultural eutrophication (Carlson 1977). Utah DEQ has used a TSI score of 50 as a threshold value to indicate impaired water quality in many of the TMDLs completed for excess nutrients in lakes. In order to reach a TSI of 50 for chlorophyll *a* the concentration of chlorophyll *a* has to be higher than 7.22 micrograms per liter ($\mu\text{g/L}$). The samples were collected from Sublett Reservoir three times during the summer of 2001 before low levels made boat access to the reservoir impossible. The samples collected were 2.99, 2.70, and 1.9 $\mu\text{g/L}$, which were well below the value suggested to indicate nuisance aquatic vegetation growths. A single sample was collected in 1997; the concentration was 3.4 $\mu\text{g/L}$ chlorophyll *a* in that sample. Based on the available data, it is unlikely that excessive nutrients are the factor effecting the phytoplankton of Sublett Reservoir. However, the emergent aquatic vegetation visually appears to be in excess. In addition, during low water events the emergent vegetation made it difficult to launch a boat to obtain water quality samples (Lay 2003). Quantification of the area or volume of the emergent vegetation needs to be conducted. However, the extent of the vegetation appears to be sufficient that beneficial uses are impaired and a nutrient TMDL should be done.

Sublett Reservoir Existing Water Quality Data

The quantity of water quality samples collected by entities other than DEQ within Sublett Reservoir is unknown. The STORET database contains no samples collected from the reservoir. Data queries from other agencies have yielded no water chemistry data. Therefore, DEQ data is the only readily available data for Sublett Reservoir.

DEQ sampled in the reservoir over the course of 2001, and additional samples will be collected throughout the various phases of TMDL implementation as budgets and sampling time frames allow. However, due to the limited number of sampling periods in the original 2001 data set, DEQ’s confidence in monthly average concentrations is low. The lack of a robust data set was due to limited budgets and, in part, to a limited time frame for collecting data. In most cases one sample was the most collected in any given month. Infrequently, multiple samples were collected in one month. This sampling design was intended to determine annual load. However, the annual load estimated by this type of design would overestimate annual load by 25 to 50 percent (Robertson and Richards 2000). To assist in the determination of seasonal components and appropriate critical conditions, the data will be presented as monthly averages in the following tables, while period of record averages are presented in the text and other tables and will be used for any future load calculations. For those cases when a parameter was below detection limits, half the detection limit was used to calculate the monthly average and used as part of the period of record average.

Three sample locations were set up on Sublett Reservoir with sampling beginning in April of 2001. The first sampling site was set up near the dam in the area of the deepest part of the reservoir or “Zmax”. The Zmax site was used to determine average concentrations for the water body. At this location, the reservoir waters have had a chance to equilibrate and begin to function as a lake rather than as a stream. Two additional sampling locations were established in each arm of the reservoir. These locations were used to understand the relative contribution from the two major inputs. The chemical constituents within each site seemed to be very similar throughout the sampling period. However, there seemed to be some differences among sites.

In order to determine if this was the case, analysis of variance was conducted to test the null hypothesis.

H_0 : Sublett Creek Arm = Lake Fork Creek Arm = Z_{max} .

H_a : Sublett Creek Arm \neq Lake Fork Creek Arm $\neq Z_{max}$

Each constituent sampled at the three locations was tested using Systat 7.0. For all constituents (secchi depth, nitrogen, SC, TP, NH_3 , temperature, DO, and TSS) the null hypothesis was not rejected ($p > 0.05$). These constituents can be pooled for discussion. The relationship between sites is as expected for such a small water body with such similar water sources in both small tributaries.

The levels of the measured constituents (Table 37) in Sublett Reservoir are very low. These levels in most all cases indicate a high assimilative capacity of the reservoir, low use, and low degradation. For example, TSS at Z_{max} averages 1.16 mg/L, at the Sublett Arm 2.00 mg/L, and at the Lake Fork Arm 1.00 mg/L. Average TP was 0.028 mg/L at Z_{max} . Total phosphorus in both arms (0.034 and 0.036 mg/L) was only slightly elevated due to the proximity to the sources.

Carlson's TSI can also be used to determine if nutrients are in excess. Again, the TSI for TP score above 50 has been used in other states as a threshold for excess nutrients. A TSI of 50 corresponds with 0.025 mg/L of TP, 2 m secchi, and 7.25 μ g/L chlorophyll *a*. Based upon these numbers Sublett Reservoir exceeded the threshold value for TP at all locations a total of 12 of the 16 times the reservoir was sampled as the summer progressed. The secchi depth threshold was exceeded several times throughout the summer. However, this was likely due to actual depth to bottom, rather than a lack of water clarity. In those samples secchi depth equaled lake bottom depth. Chlorophyll *a* was sampled only at Z_{max} . At that location, a TSI of 50 was never exceeded. Overall, the average TSI scores for all three locations were well below the 50 threshold as seen in Figure 33.

The TSI scores in a reservoir can be very complicated under severe draw-down events such as the summer of 2001. Phosphorus can be mobilized from the sediments in the deeper portions of the lake due to natural processes. When a lake is drawn down, this layer of water becomes mixed with the epilimnetic (and low TP) waters, enriching a system later in the year when it is typically poor in nutrients. In addition, sediments rich in adsorbed TP can be remobilized as the waters recede. Both of these situations likely occurred in Sublett Reservoir through the summer of 2001. Further investigations are required to determine if there is a significant trend in TSI scores. However it appears from TSI scores for total nitrogen (TN) and TP, that the reservoir is nutrient limited as the TSI scores were typically in the mid 30's, while secchi scores were near 50. Thus, it is not likely that nutrients are impairing the phytoplankton component of the aquatic vegetation.

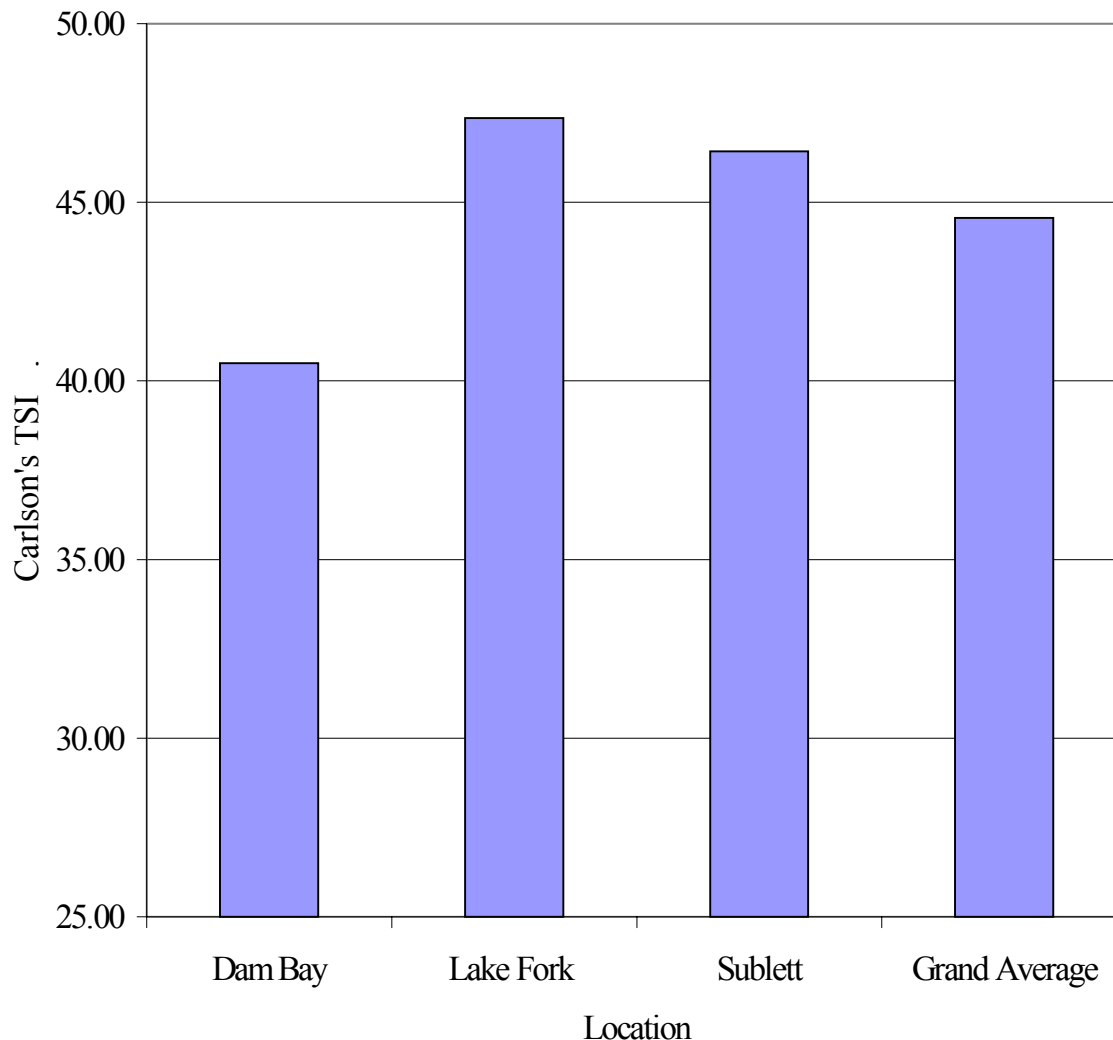


Figure 33. Sublett Reservoir Trophic State Index scores.

Individually, TSI scores can give additional information when interpreting single constituents. However, the determination of trophic state should not be based upon a single component of the index. Individually the components of the overall TSI score make it appear that Sublett Creek is a slightly eutrophic reservoir (see Figure 34). Much of the weight is placed on the secchi and TP values. However, the average chlorophyll *a* TSI score (38.87) does not reflect this trophic state. Likewise, the TSI based upon secchi should be much lower as some of the values where secchi depth equaled bottom depth were included. Furthermore, TN also appears to be well below the eutrophic threshold of 50 (TN TSI averages 35.64). However, TP was elevated (52.38) and may influence the production of aquatic vegetation in Sublett Reservoir to a greater extent than nitrogen. The average TSI score for all components for the sampling period of 2001 fluctuated along the same trend as TSI-TP. Thus can be seen the weight TSI-TP has in the overall average. However, the overall TSI score indicates that Sublett Reservoir is a mesotrophic reservoir. Reservoirs of this type are well balanced in terms of fish production and water quality. In more oligotrophic lakes, fish production is less while water quality is higher. The same trade-off exists for eutrophic waters: higher fish production, lower water quality. Therefore, mesotrophic lakes are viewed by many as the ideal target; hence, the many states and entities that use a TSI target of 50 as their management goal.

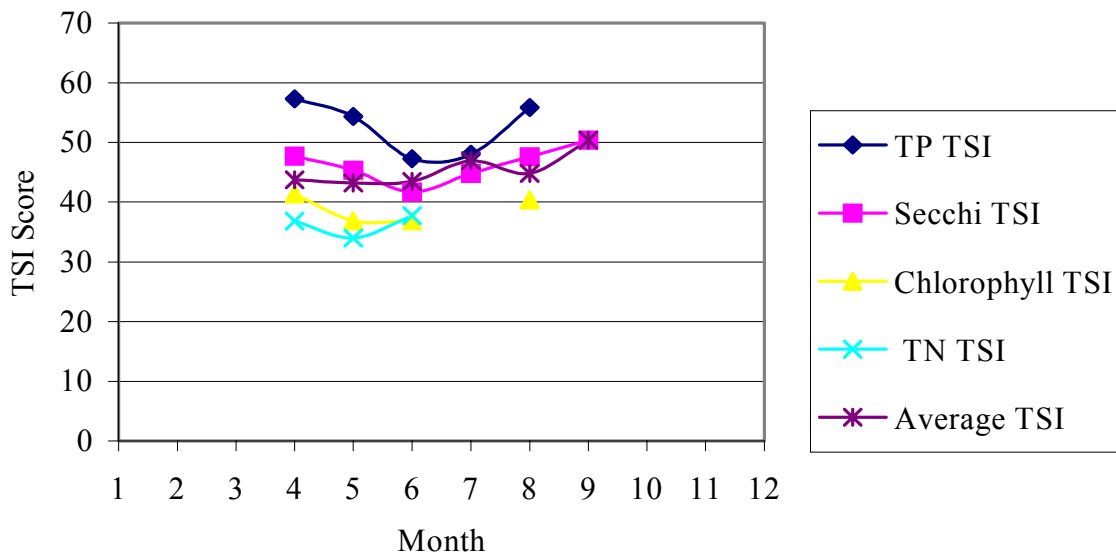


Figure 34. Average lake wide Trophic State Index scores throughout the 2001-sampling season.

Bacteria samples were collected near the Sublett Creek Arm. This area is in close proximity to a boat launch area. *E. coli* were seldom present in the samples, and when they were, it was in very low numbers (2 colonies/100 ml). These data are presented in Table 37.

Temperature and dissolved oxygen profiles were also collected throughout 2001 (Figure 35 and 36) at Zmax. At the end of April, the reservoir appeared to have a weak stratification although the maximum measured depth was only 10 m. The weak stratification may have set up at the beginning of the month with the bottom of the thermocline was near 7 m in depth and epilimnion was near 2 m. As the epilimnion warmed throughout May, the stratification became less pronounced with only two layers. By the end of May the epilimnion was down to 6 m and the thermocline was down to 10 m, irrigation withdrawals began to steadily remove water from the system. The bottom withdrawal system employed by the reservoir removes the colder hypolimnetic waters leading to a more isothermal state as the year progresses. This condition is further aggravated by the size of the water body, windy conditions, and the influx of spring water in the tributaries. Small systems, such as Sublett Reservoir, will mix readily, thus becoming polymictic (many small stratifications occurring between wind events). Additionally, through the irrigation season approximately 70 percent of the depth is removed from the lake. This water is taken from the bottom portion of the reservoir. With the addition of 15-16 °C water from the streams almost year round, the lake has a limited time frame to stratify. The stratification began to break down in late June and the lake was isothermal from late June throughout the remainder of the summer. This was likely due to strong wind events that drove the epilimnion deeper and the bottom withdrawals that removed the colder hypolimnetic water from the reservoir.

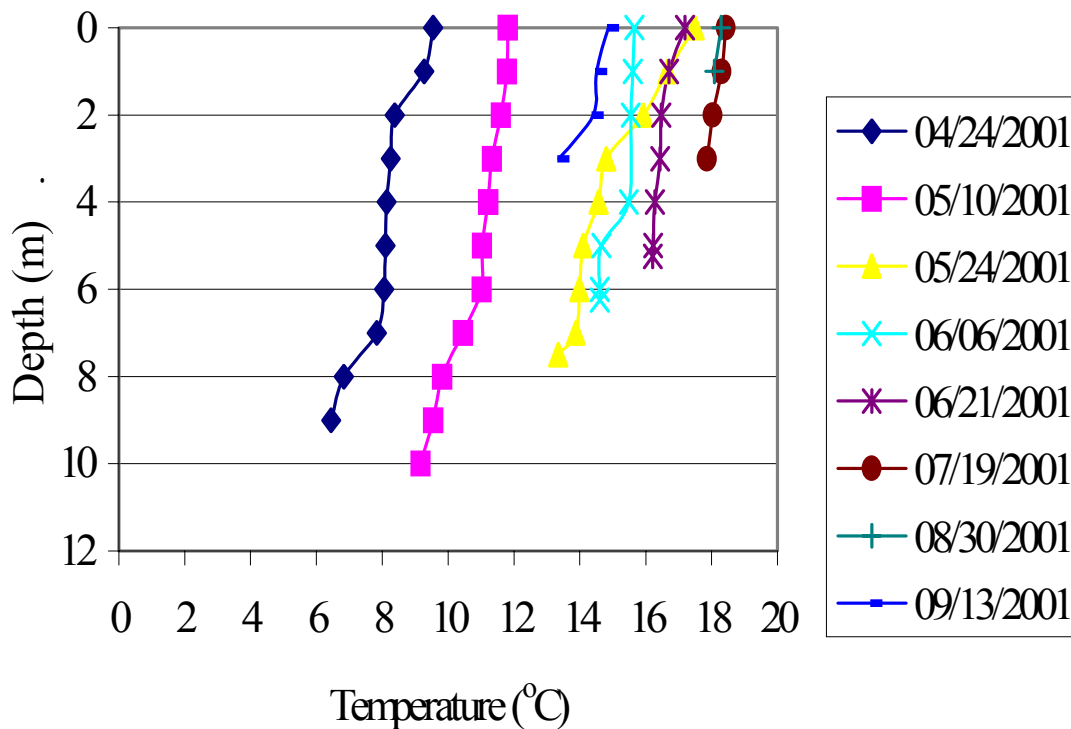


Figure 35. Temperature/Depth profiles.

Dissolved oxygen profiles were collected along with the temperature profiles. Similar situations were observed. During the early spring stratification, DO levels were relatively high throughout the water column, although some oxygen depletion was noted near the bottom meter of the reservoir. The oxygen depletion became less evident as the year progressed, likely due to isothermal mixing of the water body with well-oxygenated stream water and water from or near the reservoir surface. In prior discussions, DEQ had determined that excess aquatic growths had not occurred in Sublett Reservoir during the 2001 sampling period. The DO and pH data support this contention. In addition, in lakes and reservoirs with significant primary production (or nuisance aquatic growths) the hypolimnetic waters will often become anoxic. In lakes that are isothermal, this situation rarely happens. However, oxygen can become depleted in the lower bounds of some lakes and a chemocline can be established. A chemocline was not established in Sublett Reservoir and oxygen depletion did not occur. Therefore, DEQ finds that Sublett Reservoir is likely not polluted with oxygen demanding materials.

It appears from the TSI data and water column chemistry data that suspended sediment and DO are within the bounds of water quality determined to be supportive of the designated beneficial uses. Consequently, DEQ will not complete a suspended sediment or DO TMDLs on the reservoir. However, based upon the TSI scores for TP, the quantities of emergent vegetation at many locations throughout the reservoir, and the nutrient concentrations found in the two tributary waters, a nutrient TMDL is required for Sublett Reservoir.

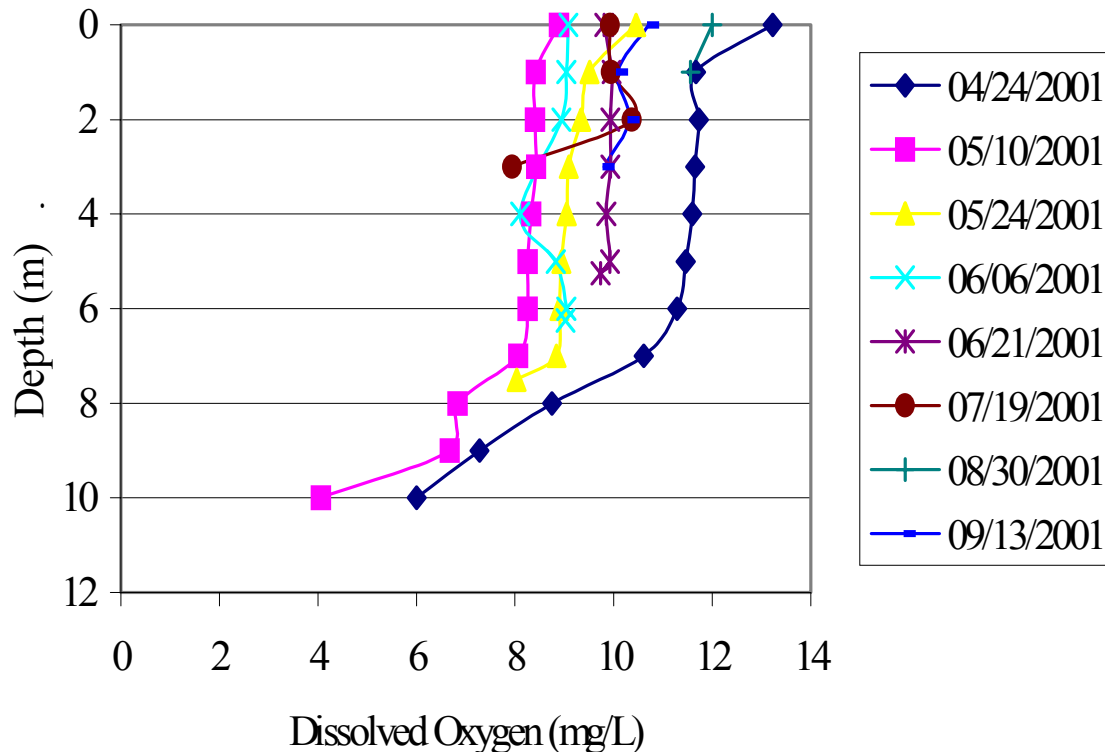


Figure 36. Dissolved oxygen (mg/L)/depth profiles.

The overarching water quality problem in Sublett Reservoir is the same as in the creek below the reservoir and it is not any of the previously mentioned water quality parameters. It is simply flow alteration. Typically, any water quality guideline or standard, if it is violated, is violated when the water is removed from the reservoir. Temperature, low DO, and TSS are usually the parameters associated with flow alteration problems. In the reservoir's case, these parameters are buffered by the upstream watersheds' water source and quality. However, the beneficial uses of the reservoir remain in jeopardy due to long periods of minimum pool volume during the late summer irrigation period. Flow issues are by far the most complex of the listed parameters. It appears that the beneficial uses are fully supported in spite of elevated nutrients and severe draw-down events. Again, this status is likely due to the high quality of the upstream waters and minimal impacts in the watersheds. Flow issues are further compounded in that the reservoir was built solely for irrigation use and the recreation and aquatic life beneficial uses are ancillary to that use. DEQ will continue to list Sublett Reservoir for flow alteration until such time that flow alteration issues are better understood politically and scientifically.

Table 37. Measured water quality constituents in Sublett Reservoir.

Month	No of Samples	TSS (mg/L) ^a	Total NH ₃ as N (mg/L) ^b	Total NO ₂ + NO ₃ as N (mg/L) ^c	Total P (mg/L) ^d	Temp (°C) ^e	Dissolved Oxygen (mg/L) ^f	Bacteria <i>E. coli</i> (Col/100 ml) ^g
January								
February								
March								
April	3	1	0.006	0.005	0.035	11.45	9.09	
May	6	1	0.010	0.005	0.035	14.53	9.01	2
June	6	2	0.009	0.006	0.027	16.22	9.62	1
July	2	1	0.007	0.003	0.032	17.89	10.26	1
August						18.29	11.63	1
September						14.63	10.46	2
October								
November								
December								
Annual Average		1	0.009	0.006	0.032	15.06	10.12	1
Standard Deviation		1	0.003	0.001	0.012	3.06	1.08	

a Total suspended solids in milligrams per liter, TSS detection limit = 1 mg/L.

b Total ammonia as nitrogen in milligrams per liter.

c Nitrite plus nitrate in milligrams per liter, as nitrogen. NO₂+NO₃ detection limit = 0.005mg/L.

d Total phosphorus in milligrams per liter.

e Temperature in degrees Celsius.

f milligrams per liter.

g colonies per 100 milliliters.

Point and Nonpoint Sources

Sublett Reservoir is a §303(d)-listed water body; two sixth field HUCs (170402100403 and 170402100404) form its watershed. The land use from within these watersheds is considered to contribute to Sublett Reservoir as the reservoir is the pour point for both sixth field HUCs. The GIS coverage indicate that 100 percent of the land use in both sixth field HUCs is rangelands. The major sources of nonpoint source pollution in the watershed come from activities associated with these land uses. Additional sediment sources include unstable banks and reentrainment from the riverbed itself. However, quantification of these sources has not been completed. As of yet, no CAFOs or other point sources are known to exist within the watershed.

2.4 Data Gaps

Given the limited amount of data collected in the Raft River Subbasin data gaps abound. The most significant of these is the overall lack of data in wet or even normal water years. Consequently, any conclusions drawn on the current data set could be viewed as flawed. However, a lack of data has not been viewed as a reason not to proceed with TMDLs.

Lack of flow information is the most critical data gap. One of the reasons for this data gap is little USGS gauge coverage. Consequently, little or no statistical relationships could be formed with other ungauged watersheds. Drought conditions also affected our flow information as many streams were dry for extended periods of time; in normal or wet years these creeks may have water in them. As a result, some creeks show poorer water quality in comparison with BURP data collected in wetter years. However, this situation may revert to conditions seen before the drought. Further monitoring in these systems is required to assure DEQ that the conclusions drawn based on the current water cycle holds true under wetter or more normal years.

Nutrients are a listed pollutant on many of the streams within the subbasin. However, current water quality data do not support the listing of most streams for excess nutrients. Chlorophyll *a* information also supports the contention that nutrients are not degrading the water quality in most streams in the subbasin. However, the chlorophyll *a* data was very limited (a single sample in a single year). A fuller collection of both sestonic and benthic chlorophyll *a* samples is needed to make the SBA conclusions tighter. In addition to better chlorophyll *a* collections, an assessment of the emergent aquatic vegetation within the reservoir is needed. Currently it is assumed that the emergent vegetation is at nuisance levels due to a visual observation of the reservoir area covered by the vegetation. A quantification of this coverage needs to be completed during the implementation phases of the TMDL process.

A final data gap concerning biological communities exists. Fisheries information is very weak within the subbasin. It is unclear if some streams contain, or ever contained, salmonids. Current fisheries information needs to be collected to determine if salmonid spawning is an existing use.